Act 147 sec. 47

An Act Relating to Capital Construction and State Bonding

High Performance School Design and Construction Standards: Recommendations for Vermont Public Schools

Report to the House and Senate Committees on Institutions

January 15, 2007

Submitted by: The School Construction Standards Committee

The following report is presented as charged by Act 147, sec. 47.

High Performance School Design and Construction Standards: Recommendations for Vermont Public Schools

The School Construction Standards Committee met throughout the summer and fall of 2006.

Committee participants
Cathy Hilgendorf, School Construction Coordinator, Department of Education, Committee Chair
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Norman Etkind, Director, School Energy Management Program, VT Superintendents Association
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BACKGROUND
The committee was created to "develop a comprehensive proposal to incorporate high performance school design and construction standards into Vermont school construction projects that address indoor environmental quality, energy efficiency, use of renewable energy, water efficiency, building materials selection, building siting, construction practices, and ongoing building operations and maintenance.".

"High Performance" describes buildings designed, constructed and operated to maximize the comfort and health of the occupants, minimize negative environmental impacts, maximize energy efficiency and provide sustainable spaces for living, working and learning.

Considering the large stock of aging school facilities, the state's greenhouse gas reduction initiatives, the need to reduce operating costs, and a new energy code for commercial buildings, it may be the right time to focus on sustainability, cost effectiveness, and forward thinking when improving our school buildings.

A committee review of common practices in recent construction and renovation confirmed that school buildings in Vermont are generally not being built to a high performance standard and have room for improvement. The committee was also aware that several states and industry groups had already developed versions of a high performance design and construction standard and that it would not be necessary or prudent for us to create our own.

HIGH PERFORMANCE CONSTRUCTION AND OPERATION PROTOCOLS
The most widely recognized green building design and rating standard is the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program which offers third-party certification of a building's compliance with various levels of high performance. LEED is the standard to which many commercial buildings are compared, and there are LEED-affiliated professionals on the committee and in most of the major architectural firms in the U.S. and in Vermont.

Another construction protocol in the U.S. is Green Globes, a design and rating tool for commercial buildings developed by the Green Building Initiative and touted as an easier, cheaper and faster alternative to LEED.

Additionally, a regional group including several Vermonters, coordinated by Northeast Energy Efficiency Partnerships (NEEP), has been working for more than two years to develop a school-specific high performance standard designed for the northeastern climate. State education officials, engineers, energy experts, and architects started with the Collaborative for High Performance Schools (CHPS) standard developed for California, and then adapted for Massachusetts and reworked it to better fit the weather, regulatory environment and values of New England schools. The resulting standard, the "NEEP Protocol", addresses not only the physical structure to be built but also a process for achieving this goal in a cost effective manner and ensuring that the building would be maintained to sustain its higher level of performance.

Representatives from each of these three organizations came to Vermont upon the committee's invitation, presented their programs and addressed our questions. In evaluating the existing design and rating standards, it was important to the committee that the standard be easily adaptable to Vermont's fiscal, regulatory and educational needs. The committee chose the NEEP Protocol as most closely meeting Vermont's needs. Our evaluation criteria and results are included as Appendix B.

NORTHEAST HIGH PERFORMANCE SCHOOL PROTOCOL
Also known as the NEEP Protocol

NEEP's new design and operations guide for high performance school buildings has been completed and is now ready to be used to help create energy-efficient, sustainable, healthier learning spaces in northeast states.

Overview

The protocol is designed to be used by the state as a set of criteria for determining that a building project meets a high performance standard. Certification as a High Performance School Building will involve meeting the requirements of a set of prerequisites in seven criteria categories (listed below). A number of "elective credits" are also available to be used as part of a certification process. A complete copy of the NEEP Protocol is included as Appendix A of this report.

Vermont Addenda

The Protocol Addenda (Appendix C) adjusts and aligns specific criteria to match Vermont code, conditions and needs.

Criteria Categories

1. *Policy and Operations:* The seven prerequisites in this section frame the responsibilities of the school district to implement and carry out the practices built into the protocol to attain ongoing high performance. Three categories of elective credits acknowledge forward-thinking practices and policies to set a community example for preventive maintenance and reduced fossil fuel consumption.
2. *Indoor Environmental Quality:* Eighteen prerequisites and nine elective credit categories focus on maximum use of natural light, optimum and efficient ventilation, and indoor air kept free of pollutants and contaminants.
3. *Energy Efficiency:* The Vermont Addenda to the protocol (Appendix C) aligns the protocol's six prerequisite and seven elective credit categories in this section with Vermont's new commercial energy code through creating a set of design and operating criteria to maximize efficiency of all energy using components of a school building, during both design/construction and ongoing operations.

4. *On-site Renewable Energy:* In addition to the protocol's elective credits, a Vermont prerequisite is a feasibility study to determine on-site renewable energy opportunities.
5. *Water Efficiency*
6. *Materials Selection and Specification*: Responsible purchase, reuse and disposal of building materials is achieved via three prerequisites and seven elective credits, and use of building materials manufactured in Vermont is encouraged.
7. *Site Selection and Layout:* Four prerequisites and several elective credits promote the protection of both students and the environment by locating and orienting school facilities to make maximum use of existing infrastructure and daylight, minimize transportation requirements and protect greenfields.

Certification and Verification

There are various alternative methods which can be used to determine if a construction project has followed a prescribed design and construction criteria and meets the definition of a high performance building. Self-certification and documentation is a process which relies upon the owner and architect to verify that the standard has been followed and conditions have been met. Third-party verification engages an objective outside source to analyze the required documentation and determine its compliance with the criteria. Both NEEP and VEIC (Vermont Energy Investment Corp) have expressed interest and willingness to assist Vermont in setting up a certification and verification process to ensure that high performance goals are met.

COST IMPLICATIONS

First costs

There are misconceptions regarding the cost of high performance building. The data currently available summarizing costs and benefits of dozens of schools built to a high performance standard show there is a first cost premium averaging 3 percent or less with an average return on investment for that premium of greater than three to one. See Appendices E and F.

Life Cycle Costs

Cost effectiveness over time is at the heart of a high performance building and is the key to why building to a high performance standard is fiscally responsible. "Going green" relies upon the willingness to view "cost" as more than monetary and as more than just up-front initial expense. A careful analysis of a building's initial cost as well as its life cycle expense demonstrates the benefits of using a high performance design. In contrast, there may be substantial long-term costs for less efficient design, construction and maintenance choices. Traditional construction, designed primarily to reduce up-front cash outlays, often results in a building that is less affordable over the long-term. Because the amount of money spent on operations and maintenance over the life of a building is typically several times the amount of money spent on the design and construction process, making choices based on lowest life cycle cost is very important.

Integrated Design to Maximize Cost Effectiveness

Unless consciously designed to achieve a high performance result, awarding work to contractors offering the lowest bid will continue to encourage firms to pursue minimum required levels of performance at the lowest possible initial cost. The local school board, the designers, and the builders must all work as an effective team to reach a high performance standard. School boards must consider high performance design when selecting an architect, and the architect's initial design and specifications must be based on an integrated high-performance model. Then all members of the construction team must adopt the high performance goals. All must work together effectively to realize a high performance building and long-term savings for the taxpayers.

Alternatively, a continuing focus on fast-track pre-vote planning, initial cost, and lowest bids for construction will continue to dictate undesirable building performance and higher operating costs to be paid by the Vermont taxpayers who own school buildings for generations.

Energy Costs

There are clear and easily quantified economic benefits in terms of energy use for pursuing high performance construction and operation standards. Energy savings alone can be as much as 30 percent greater in a "green" building than in buildings designed only to meet code minimums. It is, therefore, easy to make the business case for a high performance approach as outlined in the Appendices E and F.

Cost Implications Summary

It is the determination of this committee that the most fiscally prudent decision for Vermont taxpayers is for major state-funded school construction projects to be built to a high performance standard. That stated, the committee also acknowledges that schools are under scrutiny to cut costs and cannot absorb any additional up-front costs, despite long-term benefits. If the Legislature values energy efficient high performance construction and opts to require school districts to meet higher standards, the Legislature must also find a way to help school districts fund it.

HEALTH AND EDUCATIONAL BENEFITS

Another significant reason to choose HP is the non-energy benefits. Children spend vast amounts of time in these facilities during critical physical growth periods. The health of students' growing bodies is disproportionately affected by indoor pollutants. There is an expanding body of research indicating that high performance approaches yield considerable health and productivity gains. Improving lighting and indoor air quality in schools improves student learning ability and resulting test scores. Faculty and staff productivity are also increased. At the same time, student, staff and faculty sick days are reduced.

OPTIONS FOR VERMONT

The Legislature's options in encouraging high performance school facility standards range from making compliance mandatory to varying degrees of state aid incentive to completely voluntary with no ties to state funding.

Mandate

The surest way to integrate high performance principles into school facilities would be to require districts to comply with a high performance standard. If districts perceive that added costs would not be worth the benefits, this could result in fewer facility improvements and a potential for increased incidents of deferred maintenance. The state agencies involved in this committee do not support unfunded mandates for school districts.

Incentives

Tying state school construction aid to achieving a high performance construction standard could be accomplished in several ways. A project could be denied state aid for not following the protocol or funding assistance could be reduced. Alternately, the state could offer the standard level of state aid to "traditional" projects, and a higher level of aid for projects certified as meeting the NEEP Protocol. In New Hampshire, for example, projects achieving a high performance standard are paid 3 percent of the project cost beyond the level of state aid the project would otherwise be eligible to receive. In Massachusetts, the HP incentive is 2 percent.

Voluntary
High performance standards and resources may be offered to districts as a voluntary option. Although the benefits of high performance are obvious and valuable to many, if no state aid incentives are available, many districts will not incorporate high performance principles into their projects.

CONCLUSION & RECOMMENDATIONS
The Committee recommends the adoption of the NEEP High Performance Schools Protocol with the Vermont Addenda to improve the long-term cost-effectiveness of school construction. However, unless the Legislature provides the necessary funding, we reluctantly cannot support increasing local costs and adding to educational funding pressures by requiring school districts to comply.

If the Legislature adopts a high performance construction standard for school buildings, issues to be explored further include:

1. What size and type project should be subject to the HPS protocol?
2. Will there be state funding to cover the early design and engineering costs? Will there be additional state aid to pay for the up-front construction cost differential?
3. What number of elective credits would be required or encouraged with incentives?
4. How will the verification process work?

Should the Legislature take action on this issue, comments from the Committee on these points are as follows:

1. What size and type project should be subject to the HPS protocol? Due to the extra process and overhead involved, small projects to extend the life of existing buildings should not be subject to HPS protocol. Such limited-scope projects should instead be encouraged to follow the HPS standards as they may apply to their project. The requirement to do HPS would apply to all new construction projects and to renovations in excess of $2 million and involving more than 50 percent of the existing footprint of the building.
2. Early involvement of the design team is critical in order to create an HPS facility. School districts do not have resources, especially before a bond vote, to cover any increased costs. Therefore, the Legislature must determine the funding source for the additional up-front architectural and engineering costs associated with HPS design as well as any increased costs of construction.
3. What number of elective credits would be required or encouraged with incentives? Many of the incremental credits are not difficult to achieve and a minimum number of elective credits should be required for HPS certification.
4. How will the verification process work? Details of the verification and certification processes will need to be developed, and the Committee has identified parties interested in assisting with this process.

Appendices:

A. Northeast High Performance School Protocol
B. Committee's Evaluation Criteria
C. Vermont Addenda to Protocol

D. “Why Build a High Performance School Building?” Harris (October ‘06)
   Materials in support of HP construction from Efficiency Vermont and VEIC
E. “Design Costs For High Performance School Construction” Russell (December ‘06)
F. “Greening America’s Schools Costs and Benefits” Kats (October ‘06)

Northeast High Performance School Protocol

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I. Introduction

The purpose of the Northeast High Performance School Protocol is to encourage the construction of schools that provide premium educational environments while providing important benefits for students, educators, administrators and the public. High performance schools provide high quality learning environments, conserve natural resources, consume less energy, are easier to maintain, and provide an enhanced community resource.

High performance schools are thermally, visually, and acoustically comfortable. Teachers, students, and administrators are neither too hot nor too cold as they teach, learn, and work. High quality lighting assures that visual tasks are made easier. Students and teachers can hear each other without the distractions of ventilation systems or noise from outside or adjoining spaces.

High performance schools take advantage of recent advances in energy efficiency and incorporate heating, cooling, and lighting systems that produce the highest comfort levels for the least cost. Daylight is brought into the school to enhance the learning environment and decrease the need for electrical lighting. The building shell integrates the most effective combination of insulation, glazing, and thermal mass to ensure energy efficiency and occupant comfort. Modern plumbing fixtures and innovative water use strategies combine to reduce water consumption.

Healthy indoor air is another important component of high performance schools. Air intakes are located away from potential sources of contamination and ventilation systems are designed to optimize fresh air. Architects and engineers incorporate the best design practices to prevent water from entering wall and roof assemblies, preventing mold growth and/or leading to premature replacement of indoor finishes and even structural elements.

The school's site development and construction conserves valuable resources. Additionally the site is convenient to the community, encouraging bicycle, pedestrian, and mass transit access. This environmental stewardship becomes a resource for teachers, students and the community providing important examples of responsible development.

Above all, a high performance school provides an environment that enhances the primary mission of public schools: the education of future citizens. This protocol provides guidelines for the construction of new schools and the renovation of existing schools. The prerequisites outlined in this document represent the core requirements for the establishment of high performance schools. The optional credits provide opportunities for communities to further enhance the educational environment.

II. High Performance School Protocol – Certification Process Details

The Northeast High Performance School Protocol (hereafter Protocol) details performance standards and best practices for energy efficient, sustainable school building design and construction. While the Protocol is appropriate for use in the planning and design of any school building, it is intended for use by individual state education departments as a guide to meeting state mandates and/or performance based incentive programs.

The Protocol is divided into eight sections: Policy and Operations, Indoor Environmental Quality, Energy Efficiency, On-Site Renewable Energy, Water Efficiency, Materials Selection, Site Selection, and Design Innovation. Each Section contains a list of criteria or standards, a description of the standard, the reason it is included, how to document compliance and additional resources available. These criteria are listed as prerequisites (required in the design) or electives (optional criteria that lead to enhanced performance). The prerequisites alone define a high performance school and can be achieved in renovation/modernization projects as well as new construction projects.

It is anticipated that the certification/compliance process will vary from state to state, and each state will develop and maintain a certification guideline that assists participants through the certification process. In general, state certification involves meeting the requirements of the prerequisites in this document. Individual states may also require that some Protocol “elective credits” be met in order to gain certification. In either case, documentation of compliance for an individual prerequisite or elective criteria to the state education department consists of the documentation listed in the Protocol.

State-specific guidelines and requirements can be found in the state addenda attached to the Protocol.

The following is an example of possible state-specific certification requirements:

Required: Meet all prerequisites

> *Prerequisite exceptions:* Projects may be exempted from individual prerequisites through a variance process.

Required: Obtain a minimum of 16 elective credits consisting of the following:

- **Policy and Operations** – Obtain a minimum of 2 elective credits
- **Indoor Environmental Quality** – Obtain a minimum of 4 elective credits
- **Energy Efficiency** – Obtain a minimum of 2 elective credits
- **On-Site Renewable Energy** – No elective credits required
- **Water Efficiency** – Obtain a minimum of 1 elective credit
- **Materials** – Obtain a minimum of 3 elective credits
- **Site Selection and Layout** – Obtain a minimum of 2 elective credits
- **Innovation –** No elective credits required
- **Other** – Obtain a minimum of 2 additional elective credits from any category

Codes and Regulations

State, local, and federal governments maintain a collection of codes and regulations that apply to the construction and operation of public schools. This Protocol does not attempt to present or replace any regulations or code requirements. All relevant codes and regulations should be adhered to and the adoption of this Protocol, or any of its provisions, should be considered as enhancements that improve the educational environment beyond what is required by the appropriate codes and regulations.

III. High Performance School Prerequisites – Overview

Each of the criteria in the Protocol describes a “best practice” in the design and construction/reconstruction of a school building. The criteria reflect commercial building codes and standards and standard school construction regulations and standards and would be included in the design of any modern school. What differentiates a *high performance* building from a standard building is the clear *above code* design for energy and indoor environmental quality and the *integration of the building’s mechanical systems* to achieve these efficiencies. A high performance *green* building then integrates these high performance elements with renewable technologies and sustainable materials, site choices, and elements.

Although the Protocol provides for many optional enhancements for school projects, there are some basic procedures and practices that represent the *essential requirements* for high performance school projects. The prerequisites that are considered essential to high performance schools are outlined in the table below. Each of these prerequisites is presented in detail in the appropriate section of this document.

The highlighted prerequisites are those that can carry an incremental cost. Designing to these prerequisites alone may add cost, but the savings are projected to be eight times the initial cost (based on a study conducted by VEIC and HMFH Architects using eight of the recently completed Massachusetts Pilot Project schools).

The key to an energy efficient high performance school is both the design process AND what happens after the building is occupied! These Policy and Operations prerequisites are written to define a district strategy that guides the coordination of operations and maintenance plans with financial and procurement plans.

Summary Tables

Policy and Operations Prerequisites

Required	**PO P 1.** The school district must create a high performance design advisory committee or appoint an individual trained in high performance school issues to oversee the implementation of an integrated design approach and ensure that the high performance standards and the overall goals of the protocol are met and that they are consistent with state policy.
Required	**PO P 2.** Develop policies and procedures for the sharing of facilities between the school district and the town for recreational and other community purposes.
Required	**PO P 3.** Implement the EPA’s Tools for Schools program or an equivalent indoor health & safety program for the new or renovated school. Designate a trained staff person as a point of contact for the EPA Tools for Schools program or its equivalent.
Required	**PO P 4.** Implement a school maintenance plan that includes an inventory of all equipment in the new or renovated school and its preventive maintenance needs.
Required	**PO P 5.** Establish a written policy that all newly purchased equipment and appliances to be used in the school be ENERGY STAR compliant. Additionally, the policy must prohibit the purchase of low efficiency products, including incandescent task lights, halogen torchieres, and portable electrical resistance heaters.
Required	**PO P 6.** Adopt a no idling policy that applies to all school buses used to transport the students of the school.

Required	**<u>PO P 7.</u>** Use no CFC- or HCFC-based refrigerants in building Heating, Ventilating, Air Conditioning, & Refrigeration (HVAC&R) systems.

Indoor Environmental Quality Prerequisites

Required	**<u>IEQ P 1.</u>** Access to Views – Provide direct line of sight to view glazing in 70% of classrooms and administration areas.
Required	**<u>IEQ P 2.</u>** Classroom Daylighting –Provide low-glare, uniformly distributed, daylighting for 75% of the total critical task areas of classrooms.
Required	**<u>IEQ P 3.</u>** Install electric lighting system to enhance occupants' visual performance with pendant or ceiling mounted high performance lighting fixtures. The lighting fixtures must incorporate High Performance "Super" T8 or T5 technology with lamp efficacy ratings of a minimum of 85 mean lumens per watt and color rendering index (CRI) ratings of 80 or higher. All lighting fixtures must include glare control features.
Required	**<u>IEQ P 4.</u>** Design ventilation systems to ASHRAE Standard 62.1-2004: Ventilation for Acceptable Indoor Air Quality.
Required	**<u>IEQ P 5.</u>** Provide a three-part walk-off system for all active entryways to capture dirt, particulates, and moisture before they enter the building. At active entrances, provide grills, grates, etc. to remove dirt and snow. If there is a vestibule, provide a drop-through mat system within the vestibule. Avoid drain pans and traps in the vestibule to prevent a build up of moisture during summer months. Inside the entranceway, provide walk-off mats. The recommended length of interior walk-off mats is 15 feet. Provide, at a minimum, an individual mat for classroom doors that exit directly to the outdoors.
Required	**<u>IEQ P 6.</u>** Prevent water accumulation by designing surface grades to slope away from buildings and building foundations in order to drain away water, snowmelt, and HVAC condensate to prevent the accumulation of water. Rain leaders and downspouts must be directed to filtration structures, storage, or rain gardens, or to daylight provided that surface drainage moves water away from buildings. Evaporative drip pans for HVAC condensate removal are prohibited.
Required	**<u>IEQ P 7.</u>** Design and install irrigation systems that do not spray on buildings.
Required	**<u>IEQ P 8.</u>** During construction, keep materials dry to prevent the growth of mold and bacteria.
Required	**<u>IEQ P 9.</u>** If the building or a portion of the building is to be occupied during construction, meet or exceed the Recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) *IAQ Guideline for Occupied Buildings Under Construction,* 1995, chapter 3.
Required	**<u>IEQ P 10.</u>** Replace all HVAC filtration media immediately prior to occupancy.
Required	**<u>IEQ P 11.</u>** Ensure that permanently installed filtration media have a Minimum Efficiency Reporting Value (MERV) of at least 10 except for unit ventilator systems, which shall have a MERV of at least 7.
Required	**<u>IEQ P 12.</u>** Specify only electric ignitions for the following gas-fired equipment: water heaters, cooking stoves/ovens, air handling units, boilers.
Required	**<u>IEQ P 13.</u>** Locate outside-air intake openings a minimum of 25 feet from any hazard or noxious contaminants such as vents, chimneys, plumbing vents, exhaust fans, cooling towers, streets, alleys, parking lots, and loading docks. When locating an intake opening within 10 feet of a contaminant source is unavoidable, such opening shall be located a minimum of 2 feet below the contaminant source.

Required	**<u>IEQ P 14</u>.** Do not install internally insulated ductwork unless it is double-walled ductwork or includes duct liners that meet ASTM standards C1071 and C1104 for surface erosion and water vapor sorption.
Required	**<u>IEQ P 15.</u>** Prohibit fossil fuel powered mobile machinery from being used inside the building.
Required	**<u>IEQ P 16.</u>** Ensure that all classrooms meet the acoustic standards of ANSI 12.60-2002.
Required	**<u>IEQ P 17.</u>** Comply with ASHRAE Standard 55-2004 for thermal comfort standards during the heating season, within established ranges per climate zone.
Required	**<u>IEQ P 18.</u>** Adopt or develop an Integrated Pest Management program designed to exclude undesirable pests from the school buildings.

Energy Efficiency Prerequisites

Required	**<u>EE P 1</u> (A, B, or C). Energy Efficiency Standard:** Design a school that performs significantly better than schools built to current standard practice by designing **25% or more above the ASHRAE 90.1 – 2001 standard** using A) the prescriptive criteria established by the New Buildings Institute's main resource guide: *Benchmark: Energy Benchmark for High Performance Buildings*, B) the prescriptive approach outlined in the ASHRAE standards, or C) the Total Building Approach outlined in the ASHRAE standards.
Required	**<u>EE P 2.</u>** Install continuous air barriers and employ air sealing best practices to control air leakage.
Required	**<u>EE P 3</u>.** Employ best practice HVAC design techniques to improve system performance and meet ASHRAE Standard 55.
Required	**<u>EE P 4</u>.** Commission all energy using systems.
Required	**<u>EE P 5</u>.** Provide effective and complete training and documentation on the operation and maintenance of the building systems identified in the commissioning report.
Required	**<u>EE P 6</u>.** Participate in energy efficiency incentive and technical assistance programs that are available through applicable utility and governmental programs.

Water Efficiency Prerequisites

Required	**<u>WE P 1.</u>** Employ strategies that, in aggregate, reduce potable water use by 20% beyond the baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992's fixture performance requirements.

Materials Prerequisites

Required	**<u>M P 1.</u>** Specify materials that have been tested and certified for low emissions of volatile organic compounds (VOCs).
Required	**<u>M P 2.</u>** Provide an easily accessible area serving the entire school that is dedicated to the separation, collection, and storage of materials for recycling, including – at a minimum – paper (white ledger and mixed), cardboard, glass, plastics, and metals.
Required	**<u>M P 3.</u>** Recycle, reuse, and/or salvage at least 50% (by weight) of non-hazardous construction and demolition waste, not including land clearing and associated debris.

Site Prerequisites

Required	**<u>S P 1.</u>** Comply with the basic goals of responsible school site selection.

Required	**S P 2.** Site school away from sources of excessive noise, such as airport flight paths, major highways, or frequent industrial or agricultural equipment use.
Required	**S P 3.** Prepare and execute a Stormwater Pollution Prevention plan addressing erosion and sediment control that complies with the National Pollution Discharge Elimination System Construction General Permit issued by the U.S. Environmental Protection Agency.
Required	**S P 4.** Sustainable site and building layout. Implement three measures from a list of ten best practice site strategies

IV. Policy and Operations

Purpose: To ensure that integrated design, construction, and maintenance approaches consistent with the goals of the Northeast High Performance School Protocol are followed throughout the useful life of the school.

Summary Tables

Policy and Operations Prerequisites

Required	**PO P 1.** The school district must create a high performance design advisory committee or appoint an individual trained in high performance school issues to oversee the implementation of an integrated design approach and ensure that the high performance standards and the overall goals of the protocol are met and that they are consistent with state policy.
Required	**PO P 2.** Develop policies and procedures for the sharing of facilities between the school district and the town for recreational and other community purposes.
Required	**PO P 3.** Implement the EPA's Tools for Schools program or an equivalent indoor health & safety program for the new or renovated school. Designate a trained staff person as a point of contact for the EPA Tools for Schools program or its equivalent.
Required	**PO P 4.** Implement a school maintenance plan that includes an inventory of all equipment in the new or renovated school and its preventive maintenance needs.
Required	**PO P 5.** Establish a written policy that all newly purchased equipment and appliances to be used in the school be ENERGY STAR compliant. Additionally, the policy must prohibit the purchase of low efficiency products, including incandescent task lights, halogen torchieres, and portable electrical resistance heaters.
Required	**PO P 6.** Adopt a no idling policy that applies to all school buses used to transport the students of the school.
Required	**PO P 7.** Use no CFC- or HCFC-based refrigerants in building Heating, Ventilating, Air Conditioning, & Refrigeration (HVAC&R) systems.

Policy and Operations Elective Credits

1 Credit	**PO EC 1.** In addition to prerequisite P 4 above, the school district shall purchase and use a computerized maintenance management system (CMMS) in the new or renovated school. If the district already uses a CMMS, the system must be expanded to incorporate automated maintenance scheduling for the new or renovated school.
1 Credit	**PO EC 2.1.** Commit for a period of two years to purchasing, at either the municipal or school district level, Renewable Energy Certificates (RECs) or clean renewable electricity for the equivalent of at least 10% of the school's projected annual electricity needs.
2 Credits	**PO EC 2.2.** Commit for a period of two years to purchasing, at either the municipal or school district level, Renewable Energy Certificates (RECs) or clean renewable electricity for the equivalent of at least 25% of the school's projected annual electricity needs.
1 Credit	**PO EC 2.3** Obtain an additional point if the Renewable Energy Certificates (RECs) are purchased from a local (within 200 miles) generator.

1 Credit	**PO EC 3.1.** Alternative Fuel Demonstration Project Establish an alternative fuel project that demonstrates the viability of alternative fuels to the school district, the community, and the region.
2 Credits	**PO EC 3.2.** Alternative Fueled Buses At least 20% of the buses serving the school must use alternative fuel such as compressed natural gas or utilize clean technology buses with hybrid electric-diesel engines. This credit may also be achieved by committing to use B-20 diesel fuel in all the buses serving the school for a period of two years. Note: If 20% of the buses serving a school does not equal a whole number, then round down to the nearest whole number. If the number is less than one, then round up to one.
2 Credits	**PO EC 3.3.** Alternative Fueled Maintenance Vehicles and Equipment If purchasing maintenance vehicles and equipment as part of the capital budget for the school project, specify alternative fuel power such as electric, propane, or natural gas. This credit addresses lawnmowers, tractors, and maintenance trucks, but does not include life safety equipment. To achieve the credit, 50% of the cost for the above maintenance equipment must go toward the purchase of alternative-fuel-powered items.

Policy and Operations Prerequisites

The following prerequisites are essential to the construction and maintenance of a high performance school. Together they form the foundation upon which the Northeast High Performance Schools Protocol is built and set the framework for successfully completing a project that meets protocol requirements and provides a high quality educational environment for years to come.

Policy Prerequisite 1: Establish High Performance Design Advisory Committee

Required	**PO P 1.** The school district must create a high performance design advisory committee or appoint an individual trained in high performance school issues to oversee the implementation of an integrated design approach and ensure that the high performance standards and the overall goals of the Protocol are met, and that they are consistent with state policy.

District leaders who institutionalize high performance are not just building better schools, they are protecting student health, improving test scores, and lowering the district's operating expenses. To qualify for this prerequisite, the district's school board must pass a resolution that establishes the advisory committee and directs the committee to pursue an integrated design approach that complies with the NE-CHPS protocol for the projects under consideration.

Documentation for Policy Prerequisite 1

Submit a copy of the signed resolution passed by the School Board or official documentation of School Board vote.

Policy Prerequisite 2: Develop a Policy for the Efficient Joint Use of the Facility

Required	**PO P 2.** Develop policies and procedures for the sharing of facilities between the school district and the town for recreational and other community purposes.

The most successful schools have a high level of parent and community involvement. High performance schools are designed in such a way that the sharing of spaces for neighborhood meetings, recreational activities, adult education, and other community functions can take place in a safe and secure environment.

Building or renovating a school provides an opportunity for the community to incorporate municipal programs and services into the building program. During the planning stages, school districts should give careful thought to the types of programs, services, and facilities they may wish to offer via the future school building (e.g., library services, recreation services, meeting space, space for special events, etc.). As an example, if the community lacks a library, it could plan a library for shared school and community access in the new facility.

Other strategies that contribute to shared use of the school building include designing separate entrances for spaces likely to be shared, adjusting building orientation and layout to separate classroom and administration areas from shared spaces during events, and designing special features into the school that the community can use.

Joint use of recreational space is a growing trend across the country. Schools are used by a variety of community organizations for a variety of recreational purposes. Use of school playing fields by the local recreation department allows the community to optimize resources dedicated to community recreation. This prerequisite is intended to reward both schools that share their recreational space with the community at large AND communities that allow schools to use common fields and open spaces (in lieu of having the school construct its own playing fields).

Documentation for Policy Prerequisite 2

Credit S 1.8:

1) Copies of community meeting notes, minutes, or other relevant communications documenting discussions and conclusions about how the school building will be shared with the community.
2) A narrative signed by the project architect and the school superintendent documenting how the school building has been designed to optimize community use.
3) Regulations and/or policy statement governing the use of parks and recreation spaces.
4) Copy of agreement between school district and municipality on joint use of facilities.

Policy Prerequisite 3: Establish Indoor Environment Management Plan

Required	**PO P 3.** Implement the EPA's Tools for Schools program or an equivalent indoor health & safety program for the new or renovated school. Designate a trained staff person as a point of contact for the EPA Tools for Schools program or its equivalent.

EPA's Tools for Schools program is designed to identify, address, and prevent indoor air quality problems in schools. The prevention and comprehensive planning for indoor air problems is more effective and far less costly than crisis-reaction approaches. The Tools for Schools kit provides a basic set of operations and maintenance guidelines that will help prevent IAQ problems in schools. It establishes responsibilities and clear communication channels so that indoor air problems can be prevented and problems can be quickly identified and solved. In addition, the Tools for Schools system can be used to address other environmental health and safety conditions that arise.

Documentation for Policy Prerequisite 3

Submit a resolution from the school board or letter from the Superintendent declaring participation in EPA's Tools for Schools (or an equivalent program) for the school. Documentation must include the name and position of the designee who will be the point of contact for the EPA or equivalent program.

Resources

EPA, http://www.epa.gov/iaq/schools; http://www.epa.gov/iaq/schools/tools4s2.html.

Region I Environmental Protection Agency, Northeast office in Boston, Massachusetts, phone: (888) 372-7341.

Policy Prerequisite 4: Establish Maintenance Plan

Required	**PO P 4.** Implement a school maintenance plan that includes an inventory of all equipment in the new or renovated school and its preventive maintenance needs. The inventory should cover at least the following systems: • HVAC • Plumbing • Non-HVAC mechanical systems • Lighting • Building Control Systems • Life and Safety Systems • Interior Finishes • Roof systems • Switchgear The plan must address the preventive maintenance needed, include staff/vendor time and materials costs for each maintenance task, a schedule for these tasks, and clearly define who is responsible for performing the task, as well as the overall management of maintenance activities.

Regular maintenance is critically important to the operation and performance of schools. Every district has unique maintenance needs, but districts should invest sufficient staff and resources to ensure that the school's building systems continue to operate as they were designed.

High performance schools are not maintenance intensive. However, all buildings and building systems require preventative – not deferred – maintenance if performance goals are to be met.

Qualifying maintenance plans will include all regularly scheduled preventative maintenance tasks over the lifetime of the building system or equipment. These tasks include cleanings, calibrations, component replacements, and general inspections. A commissioning plan and the required maintenance documentation is an excellent starting point and reference for developing the maintenance plan. The plan must include staff/vendor time and materials budgets for each maintenance task and clearly define who is responsible for performing the task, as well as the overall management of maintenance activities.

Documentation for Policy Prerequisite 4

Submit a copy of the district maintenance plan as outlined above.

Policy Prerequisite 5: Specify Equipment Performance Levels (ENERGY STAR)

Required	**PO P 5.** Establish a written policy that all newly purchased equipment and appliances to be used in the school be energy efficient and at least ENERGY STAR compliant. Additionally, the policy must prohibit the purchase of low efficiency products, including incandescent task lights, halogen torchieres, and portable electrical resistance heaters.

The energy use of a school is not only associated by the building systems (HVAC, lighting, etc.), but also by the supplementary equipment associated with typical school operations. So called "plug loads" have become a rapidly growing portion of school operating budgets because of the reliance on computer systems and other equipment. Choosing efficient equipment has a large impact on energy consumption and costs.

The ENERGY STAR program was established to provide accuracy and consistency in energy usage ratings and to encourage the purchase of efficient equipment. The program maintains a database of compliant manufacturers and products including computers, monitors, copy machines, water coolers, printers, scanners, refrigerators, ceiling fans, and washing machines. In many cases, equipment that exceeds ENERGY STAR's efficiency requirements is available and should be considered. When ENERGY STAR compliant equipment is not available, the project owner should submit a notice of exception to the relevant high performance school administrators.

Documentation for Policy Prerequisite 5

Submit a copy of the signed resolution passed by the School Board.

Resources

ENERGY STAR, http://www.energstar.org/.

Policy Prerequisite 6: Anti-Idling Measures

Required	**PO P 6.** Adopt a no idling policy that applies to all school buses used to transport the students of the school. The policy must include the following minimum provisions: • School bus drivers will shut off bus engines upon reaching destination, and buses will not idle for more than five minutes while waiting for passengers. This rule applies to all bus use, including daily route travel, field trips, and transportation to and from athletic events. School buses will not be restarted until they are ready to depart and there is a clear path to exit the pick-up area. • Prohibit idling of all vehicles for more than five minutes (including all passenger vehicles and delivery trucks) in the school zone AND post appropriate signage. • School bus companies and drivers will limit idling time during early morning warm-up to manufacturers' recommendations – generally five minutes in all but the coldest weather and for pre-trip safety inspections. • Establish provisions for an indoor waiting space for drivers. • Evaluate and shorten bus routes whenever possible, particularly for older buses with the least effective emissions control. • All bus drivers will receive a copy of the school district's No Idling Policy or equivalent educational materials at the beginning of every school year. • Exceptions to this policy are appropriate only to meet state regulations or when running an engine is necessary to operate required safety equipment or perform other functions that require engine-assisted power, e.g. waste-hauling vehicles, handicap accessible vehicles, etc.

According to the Environmental Protection Agency (EPA), exposure to diesel exhaust, even at low levels, is a serious health hazard and can cause respiratory problems such as asthma and bronchitis. Diesel emissions are well-documented asthma triggers and may increase the severity of asthma attacks. Asthma is currently the number one cause of missed school days for American children, and asthma affects more than one in nine children in the Northeast. (Source: Asthma Regional Council website – see resources below)

Documentation for Policy Prerequisite 6

Submit a copy of signed resolution or signed school district policy including, at a minimum, the provisions outlined in this credit. Additional provisions may apply – see sample policy on Asthma Regional Council website for guidance:
http://www.asthmaregionalcouncil.org/about/BusToolkit.htm.

Resources

http://www.asthmaregionalcouncil.org/about/BusToolkit.htm.

http://www.asthmaregionalcouncil.org/about/documents/SchoolBusNoIdlingPolicy7.29.04.doc

Policy Prerequisite 7: Elimination of CFC- and HCFC-based Refrigerants

Required	**PO P 7.** Use no CFC- or HCFC-based refrigerants in building Heating, Ventilating, Air Conditioning, & Refrigeration (HVAC&R) systems.

Because chlorofluorocarbon-based refrigerants have been found to adversely affect atmospheric ozone levels, this prerequisite requires the use of alternative refrigerants in Heating, Ventilation, Air Conditioning, and Refrigeration (HVAC&R) systems.

Exception: Components of HVAC&R systems that are NOT being replaced as part of a renovation project are not subject to this prerequisite.

Documentation for Policy Prerequisite 7

Submit specifications demonstrating the use of non-CFC/HCFC-based refrigerants in all HVAC and refrigeration systems to be installed**.**

Policy and Operations Elective Credits

Policy Elective Credit 1: Purchase a Computerized Maintenance System

1 Credit	**PO EC 1.** In addition to prerequisite P 4 above, the school district shall purchase and use a computerized maintenance management system (CMMS) in the new or renovated school. If the district already uses a CMMS, the system must be expanded to incorporate automated maintenance scheduling for the new or renovated school.

Computerized maintenance management systems offer the opportunity to enhance maintenance practices through the automatic scheduling and tracking of maintenance procedures. Web based services and stand-alone products are available.

Documentation for Policy Elective Credit 1

Submit a copy of a signed contract or receipt for the purchase of a CMMS.

Policy Elective Credit 2: Purchase Clean Energy

1 Credit	**PO EC 2.1.** Commit for a period of two years to purchasing, at either the municipal or school district level, Renewable Energy Certificates (RECs) or clean renewable electricity for the equivalent of at least 10% of the school's projected annual electricity needs.
2 Credits	**PO EC 2.2** Commit for a period of two years to purchasing, at either the municipal or school district level, Renewable Energy Certificates (RECs) or clean renewable electricity for the equivalent of at least 25% of the school's projected annual electricity needs.
1 Credit	**PO EC 2.3** Obtain an additional point if the Renewable Energy Certificates (RECs) are purchased from a local (within 200 miles) generator.

Purchase electricity for the school from a provider of clean renewable electricity or Renewable Energy Certificates (RECs) such that the equivalent of at least 10% of the school's projected annual regulated electricity needs will be provided by renewable sources. Credits cannot be combined; the maximum credit is 2 credits.

Renewable energy generating facilities produce electricity that is used on-site, supplied to the appropriate regional electrical "grid," or a combination of the two. Renewable energy providers also sell Renewable Energy Certificates (RECs) that serve as credits for power produced by certain renewable energy technologies. RECs are typically purchased by utilities, which must meet legal requirements to "produce" certain amounts of renewable power depending on state regulations. The purchase of newly issued RECs supports the distribution of electricity from renewable sources and encourage the construction of additional renewable generating facilities. RECs are available for both "new" renewable energy and for energy produced by older (pre 1997) generating stations. Choosing to pay a premium for "new" RECs will most likely encourage the development of additional renewable energy facilities.

Documentation for Policy Elective Credit 2

Submit a copy of signed resolution passed by the appropriate governing body (see sample resolution below). The resolution must show the number of kilowatt hours (kWh) for which clean renewable electricity or RECs will be purchased on an annual basis.

AND, appropriate documentation from the clean power or REC supplier indicating the number of kilowatt hours (kWh) for which clean power or RECs are being purchased.

The total annual kWh used for the calculation must be the same as that used for compliance with the energy efficiency sections of the protocol.

Sample Resolution for Renewable Energy Credits

WHEREAS, the cost of conventional fuels, such as oil and natural gas is increasing, and
WHEREAS, in the last decade, Northeast has become increasingly dependent on natural gas, and
WHEREAS, fuel diversity is important for energy security reasons, and
WHEREAS, fossil fuels are limited in supply and will someday be exhausted, and
WHEREAS, fossil fuels generate pollutants when combusted, including greenhouse gases that can lead to global climate change, and
WHEREAS, renewable power is from clean, abundant energy sources, such as the sun and wind, and
WHEREAS, renewable power generates few, if any, pollutants.
NOW THEREFORE BE IT RESOLVED that the _________________ [insert name of school district, city or town] will make arrangements to purchase clean renewable electricity or Renewable Energy Certificates (RECs) for a period of two years covering at least _____ [25% or 50%] of the ____________________ [insert name of school] projected annual regulated electricity needs. The __________[insert name of school] projected annual regulated electricity needs are _____kWh [insert number of kWh].

Resources

For more information on the Massachusetts Renewable Energy Portfolio Standard, see http://www.mass.gov/doer/rps/

For more information on the Clean Energy Choice program, see www.cleanenergychoice.org/.

Massachusetts Energy Consumers Alliance, http://www.massenergy.com/Index.html

Policy Elective Credit 3: Alternative Fueled Vehicles and Equipment

1 Credit	**PO EC 3.1.** Alternative Fuel Demonstration Project Establish an alternative fuel project that demonstrates the viability of alternative fuels to the school district, the community and the region. The project must meet the following criteria: • Commit to using an alternative fuel such as B-20 diesel fuel, hybrid electric-diesel, or compressed natural gas in at least one school bus. • Develop an outreach campaign that will publicize the demonstration program to the general public. Outreach programs should include media events, the publication of educational materials, etc.
2 Credits	**PO EC 3.2.** Alternative Fueled Buses At least 20% of the buses serving the school must use alternative fuel such as compressed natural gas or utilize clean technology buses with hybrid electric-diesel engines. This credit may also be achieved by committing to use B-20 diesel fuel in all the buses serving the school for a period of two years. Note: If 20% of the buses serving a school does not equal a whole number, then round down to the nearest whole number. If the number is less than one, then round up to one.
2 Credits	**PO EC 3.3** Alternative Fueled Maintenance Vehicles and Equipment. If purchasing maintenance vehicles and equipment as part of the capital budget for the school project, specify alternative fuel power such as electric, propane, or natural gas. This credit addresses lawnmowers, tractors, and maintenance trucks, but does not include life safety equipment. To achieve the credit, 50% of the cost for the above maintenance equipment must go toward the purchase of alternative-fuel -powered items.

The purpose of this credit is to promote clean alternatives to diesel fuel and gasoline for school bus fleets, buses, and engine-driven maintenance vehicles and equipment. The district must carefully consider the pros and cons of each type of fuel. B-20 bio-diesel is a mixture of 20% agriculturally derived oils and fossil fuel. It burns more cleanly than 100% diesel fuel, although it is known to exhaust elevated levels of nitrogen oxides. Compressed natural gas (CNG) is an efficient and clean fuel. However, CNG refueling stations can be quite expensive to construct, so this option would be more attractive to communities with existing CNG fuel stations. Diesel hybrid buses employ a mixture of battery power and diesel fuel power. The technology is available for city transit buses and is currently being studied for its applicability to school buses. Early results indicate that “plug-in” hybrid electric-diesel school buses, which charge at night, exhaust few emissions, and can reduce fuel costs over the life cycle of the bus. Buses owned by contracted transportation companies may be counted toward this credit if used to transport students to and from the project school.

Documentation for Policy Elective Credit 3

Alternative Fueled Buses – Submit a letter from the project owner that includes the following:

- ❑ A description of the type of alternative fueled buses to be used to serve the school
- ❑ The total number of buses that will serve the school
- ❑ The number of buses that will be operated on the alternative fuel
- ❑ A commitment to continue the alternative fuel program as described for a minimum of two years

To document that B-20 diesel fuel will be used in *all* the buses serving the school, provide a copy of a two-year contract with a fuel supply company or transportation company (or a one-year contract with the option to renew for another year) stating that fuel supply for buses used on the daily route for collecting students will be B-20 bio-diesel. If entering into a contract at the time of program certification is not possible, submit a memorandum of understanding with the fuel supply or transportation company that clearly outlines the intention to use B-20 diesel in the buses that will serve the completed school.

If the bus or buses have not yet been purchased, provide product literature on the type of bus to be purchased and a letter from the project owner certifying that money has been dedicated to the purchase. For contracted school bus services, provide a copy of the contract with the transportation company indicating that 20% of the buses serving the school will use alternative fuel.

Alternative Fueled Maintenance Vehicles – Submit bid specifications and cost estimates for all lawnmowers, tractors, and maintenance trucks to be purchased for this school project. This credit is achieved when 50% of the combined purchase cost goes toward purchasing alternatively fueled maintenance vehicles and equipment.

Resources

http://www.eere.energy.gov/afdc/apps/toolkit/school_bus_toolkit.html

V. Indoor Environmental Quality

A quality indoor environment is crucial to the health of building occupants and the maintenance of a high level of student and teacher performance. Indoor air quality is the most obvious component of indoor environmental quality, but lighting and views of the outdoors also play a role. Proper indoor environmental quality reduces absenteeism and avoids the potential for long- and short-term health problems. Achieving excellent indoor environmental quality starts during construction and is maintained with careful long term planning. Proper building siting, the protection of building materials from moisture, daylighting, proper ventilation, and thermal comfort all contribute to indoor environmental quality. Implementing all the prerequisites in this section will provide a foundation for providing a healthy, pleasant, educational environment.

Summary Tables

Indoor Environmental Quality Prerequisites

Required	**<u>IEQ P 1.</u>** Access to Views – Provide direct line of sight to view glazing in 70% of classrooms and administration areas.
Required	**<u>IEQ P 2.</u>** Classroom Daylighting – Provide low-glare, uniformly distributed, daylighting for 75% of the total critical task areas of classrooms.
Required	**<u>IEQ P 3.</u>** Install electric lighting system to enhance occupants' visual performance with pendant or ceiling mounted high performance lighting fixtures. The lighting fixtures must incorporate High Performance "Super" T8 or T5 technology with lamp efficacy ratings of a minimum of 85 mean lumens per watt, and color rendering index (CRI) ratings of 80 or higher. All lighting fixtures must include glare control features.
Required	**<u>IEQ P 4.</u>** Design ventilation systems to ASHRAE Standard 62.1-2004: Ventilation for Acceptable Indoor Air Quality.
Required	**<u>IEQ P 5.</u>** Provide a three-part walk-off system for all active entryways to capture dirt, particulates, and moisture before they enter the building. At active entrances, provide grills, grates, etc. to remove dirt and snow. If there is a vestibule, provide a drop-through mat system within the vestibule. Avoid drain pans and traps in the vestibule to prevent a build up of moisture during summer months. Inside the entranceway, provide walk-off mats. The recommended length of interior walk-off mats is 15 feet. Provide, at a minimum, an individual mat for classroom doors that exit directly to the outdoors.
Required	**<u>IEQ P 6.</u>** Prevent water accumulation by designing surface grades to slope away from buildings and building foundations in order to drain away water, snowmelt, and HVAC condensate to prevent the accumulation of water. Rain leaders and downspouts must be directed to filtration structures, storage, or rain gardens, or to daylight provided that surface drainage moves water away from buildings. Evaporative drip pans for HVAC condensate removal are prohibited.
Required	**<u>IEQ P 7.</u>** Irrigation systems must be designed and installed so that they do not spray on buildings.
Required	**<u>IEQ P 8.</u>** During construction, keep materials dry to prevent the growth of mold and bacteria.
Required	**<u>IEQ P 9.</u>** If the building or a portion of the building is to be occupied during construction, meet or exceed the Recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) *IAQ Guideline for Occupied Buildings Under Construction*, 1995, chapter 3.
Required	**<u>IEQ P 10.</u>** Replace all HVAC filtration media immediately prior to occupancy.
Required	**<u>IEQ P 11.</u>** Ensure that permanently installed filtration media have a Minimum Efficiency Reporting Value (MERV) of at least 10 except for unit ventilator systems, which shall have a MERV of at least 7.
Required	**<u>IEQ P 12.</u>** Specify only electric ignitions for the following gas-fired equipment: water heaters, cooking stoves/ovens, air handling units, boilers.

Required	**<u>IEQ P 13.</u>** Locate outside-air intake openings a minimum of 25 feet from any hazard or noxious contaminants such as vents, chimneys, plumbing vents, exhaust fans, cooling towers, streets, alleys, parking lots, and loading docks. When locating an intake opening within 10 feet of a contaminant source is unavoidable, such opening shall be located a minimum of 2 feet below the contaminant source.
Required	**<u>IEQ P 14.</u>** Do not install internally insulated ductwork unless it is double-walled ductwork or includes duct liners that meet ASTM standards C1071 and C1104 for surface erosion and water vapor sorption.
Required	**<u>IEQ P 15.</u>** Prohibit fossil fuel powered mobile machinery from being used inside the building.
Required	**<u>IEQ P 16.</u>** Ensure that all classrooms meet the acoustic standards of ANSI 12.60-2002.
Required	**<u>IEQ P 17.</u>** Comply with ASHRAE Standard 55-2004 for thermal comfort standards during the heating season, within established ranges per climate zone.
Required	**<u>IEQ P 18.</u>** Adopt or develop an Integrated Pest Management program designed to exclude undesirable pests from the school buildings.

Indoor Environmental Quality Elective Credits

1 Credit	**<u>IEQ EC 1.</u>** Where chemical use occurs, install dedicated exhaust for pollution source control.
1 Credit	**<u>IEQ EC 2.</u>** Install ducted HVAC air returns to avoid the dust and microbial growth issues. The use of ceiling plenum return vents is not acceptable as part of an HVAC system design.
1 Credit	**<u>IEQ EC 3.</u>** Design the HVAC system with particle arrestance filtration rated at Minimum Efficiency Reporting Value (MERV) of 13 in all mechanical ventilation systems immediately prior to occupancy.
1 Credit	**<u>IEQ EC 4.</u>** Ninety percent (90%) of all classrooms shall have a minimum of one operable window per classroom that is reasonably accessible.
1 Credit	**<u>IEQ EC5.</u>** Install high intensity fluorescent lighting fixtures instead of HID fixtures in the gymnasium and other high ceiling areas.
1 Credit	**<u>IEQ EC 6.</u>** Supply temporary construction ventilation.
1 Credit	**<u>IEQ EC 7.</u>** During construction, seal HVAC supply and return openings to protect them from dust infiltration during such activities as drywall installation and floor sanding.
2 Credits	**<u>IEQ EC 8.</u>** HEPA vacuuming: Vacuum carpeted and soft surfaces with a high-efficiency particulate arrestor (HEPA) vacuum prior to completion of construction. For phased, occupied renovations, HEPA vacuum the carpet daily in occupied areas.
2 Credits	**<u>IEQ EC 9.</u>** Perform building flushout prior to building occupancy. Prior to flushout, filters must be replaced with at least Minimum Efficiency Reporting Value (MERV) 10 filters and replaced again after flushout with a minimum of MERV 10 filters. For unit ventilator systems, a minimum of MERV 7 filters must be installed and then replaced with MERV 7 filters after flushout.

Indoor Environmental Quality Prerequisites

<u>IEQ Prerequisite 1: Access to Views</u>

Required	**<u>IEQ P 1.</u>** Provide direct line of sight to view glazing in 70% of classrooms and administration areas. Qualifying spaces shall have view glazing equal to or greater than 7% of the floor area of that space. View glazing shall be clear and only include window area above 2.5 ft. and below 7.5 ft. from the floor. Install adjustable blinds to control glare.

Access to views has proven to be extremely important in educational and work environments. A human connection to the natural rhythms of the outdoor environment is important to both mental and physical health.

In order to meet this prerequisite, 70% of classroom and office space must have significant views to the outdoor environment. Qualifying classrooms and offices shall have clear windows that have a viewing area that is equal to or greater than 7% of the floor area of the space. View glazing shall be clear and only include window area above 2.5 ft. and below 7.5 ft. from the floor.

For the purposes of this credit, the following rooms are included:

- General classrooms
- Art rooms
- Music rooms
- Science rooms
- Computer rooms
- Special needs, remedial, and collaborative space
- Administration spaces

Exceptions: Photo labs, video production rooms, gymnasiums, auditoriums, and other rooms requiring limited illumination. School buildings that share at least two sides with other buildings are exempted from this requirement.

Documentation for IEQ Prerequisite 1

Submit an "Access to Views" spreadsheet or table that includes the following information:

1) The area in square feet of each classroom and administrative space. Identical spaces may be combined.

2) The area in square feet of the clear glazing installed between 2.5 feet and 7.5 feet form the floor surface of each of the listed spaces.

3) Submit floor plan and elevation drawings of each floor with spaces labeled to match their names as input into the table.

IEQ Prerequisite 2: Classroom Daylighting

Required	**IEQ P 2.** Provide low-glare, uniformly distributed, daylighting for 75% of the total critical task areas of classrooms. All daylighting designs must meet the following requirements: • The teaching surfaces, or the work plane, must be protected from direct sunlight, from vertical glazing, during normal school hours. Light shelves, blinds, and other shading devices may be utilized to meet this requirement. Areas located within 4 feet of exterior walls may be excluded from this glare elimination requirement. • Skylights and roof monitors shall also meet the above criteria unless they incorporate diffusing devices. • The daylighting system must be designed to replace a minimum of 25% of the total electrical illumination needed for the classroom areas.

	• Whenever possible, the project should be oriented to allow for northern- and southern-exposure classroom windows. East- and west-facing windows are less desirable due to morning and afternoon glare problems.

To earn this credit, 75% of the classroom critical task area collectively must be designed for daylighting and such daylighting must replace a minimum of 25% of the total electrical illumination needs for the classroom areas. Critical task area is the square footage of each classroom where teaching and learning surfaces could be placed (excludes closets, cabinets, shelving, etc.). Teaching and learning surfaces are considered to be 30 inches above the floor.

Properly designed daylighting is the best way to illuminate classrooms. Several recent studies have shown that student performance improves dramatically under daylit conditions. However, poorly designed daylighting doesn't provide the same benefits, and student performance may actually deteriorate to levels below that of the performance under artificially illuminated spaces. There is also growing evidence that daylighting positively affects circadian rhythms, playing an important role in regulating sleep patterns.

Daylighting in classrooms should be uniformly distributed and should not exceed a ratio of 8:1 of maximum footcandles to minimum footcandles. There should be limited direct-beam sunlight penetration and teachers should have control of daylight intensity and glare. It is extremely important that daylighting strategies be carefully considered. The design of daylighting systems should be entrusted to a lighting designer or architect with daylighting experience. A variety of daylighting guides and resources are listed in the resource section below.

Documentation for IEQ Prerequisite 2

Submit a narrative description and design drawings detailing the daylighting design for the school. Demonstrate that at least 75% of the total classroom critical task area will meet the above listed requirements and that the electric lighting in these spaces will be controlled (on-off or dimming) by automatic daylight harvesting controls.

Demonstrate that, as much as possible, the classroom orientation provides for northern- and southern-exposure windows.

In addition, provide results from one of the two following options:

<u>Option 1 – Computer Simulation</u>
Provide a synopsis of a computer simulation that shows that 75% of the critical task areas in the classrooms achieve low-glare, uniformly distributed daylighting. If a "one point in time" simulation is used, it should be modeled based on a sunny day, on the equinox, at noon. Daylit surfaces are to be 30 inches above the floor.

<u>Option 2 – Physical Modeling</u>
Create a physical model that contains a representative sample of the classrooms in the school. Provide a report of the modeling effort that demonstrates compliance and explains the methodology used for the measurement of daylight and the interpretation of modeling results.

For the purposes of this credit, classrooms include:

- ❑ General classrooms
- ❑ Art rooms
- ❑ Music rooms
- ❑ Science rooms
- ❑ Special needs, remedial, and collaborative space

Resources

CHPS Best Practices Manual, vol. 2, “Daylighting and Fenestration Design” chapter

LEED Reference Guide, Indoor Environmental Quality, Credit 8: Daylighting

Lighting Research Center, http://www.lrc.rpi.edu/programs/daylightdividends

Pacific Gas and Electric Daylight Initiative, http://www.pge.com/pec/daylight/daylight.shtml

HESCHONG MAHONE GROUP, INC., Daylighting Studies, http://www.h-m-g.com/

IEQ Lighting Quality (Electric Lighting) Category

Purpose: Promote improved visual performance by providing premium quality electric lighting.

IEQ Prerequisite 3: Install Low-Glare Lighting Systems in Classrooms

Required	**IEQ P 3.** Install electric lighting system to enhance occupants’ visual performance with pendant or ceiling mounted high performance lighting fixtures. The lighting fixtures must incorporate High Performance “Super” T8 or T5 technology with lamp efficacy ratings of a minimum of 85 mean lumens per watt and color rendering index (CRI) ratings of 80 or higher. All lighting fixtures must include glare control features.

Classrooms require high quality electric lighting when daylighting is not available or is insufficient. High quality electric lighting provides adequate light for the task, while improving the rendering of colors and reducing glare.

In order to provide high quality lighting, the lighting fixtures, lamps, and ballasts, and the lighting design layouts must be carefully considered.

T8 Lamps & Ballasts – Modern T8 (1” diameter) lamps paired with electronic ballasts, provide high quality lighting combined with excellent energy efficiency. Additionally these systems maintain their light output better over time than do the standard T12 (1 ¼” diameter) lamps they have replaced. High Performance “Super” T8 lamp and ballast systems provide enhanced efficiency when compared with other T8 systems. Their cost is only slightly higher than standard T8 systems, and they have become readily available through normal distribution chains.

Protocol qualifying High Performance “Super” T8 systems are listed on the Consortium for Energy Efficiency’s (CEE) website: www.cee.org. Most energy efficiency incentive programs throughout Northeast also use the CEE list for incentive qualification.

T5 Lamps & Ballasts – T5 (5/8” diameter) lamps are also excellent choices for classroom lighting. Like most T8 systems, they are paired with electronic ballasts. It is often assumed that because T8 lamps are more efficient than T12 lamps, that T5 lamps are more efficient than T8 lamps. This is not accurate, as many T8 lamps produce more light per watt (efficacy) than do T5 lamps. However, the thin profile of T5 lamps makes them ideal for use in fixtures where optical control is important. For this reason, many high performance lighting fixtures incorporate T5 lamps. Because they produce a lot of light for their size, T5 lamps produce a significant amount of glare and should only by used in fixtures that hide the lamp from direct view and optically control glare.

Systems that utilize standard output and high output, T5 lamps are eligible for meeting this prerequisite, but only when used in fixtures that hide the lamp from direct view and incorporate glare control strategies.

Fixture Types – Fixture styles that can be used to provide high quality classroom lighting and may be used to qualify for this prerequisite, include:

- ❑ Pendant mounted indirect or direct-indirect fixtures – Fixtures must have a tested overall efficiency of at least 75%, and provide no more than 40% downlight.
- ❑ Recessed or surface mounted indirect or direct-indirect fixtures – Fixtures must have a tested overall efficiency of at least 65% and shield lamps from direct view.
- ❑ Recessed advanced optics fixtures – This class of fixture is relatively new to the marketplace. Advanced optical features are used to distribute the light evenly and control glare. Tested overall efficiency must be at least 75%. Examples of this fixture style are the Lithonia RT5, Metalux Accord, and LedaLite Pure FX.

Lighting Layouts – Lighting layouts should provide even light throughout the classroom although it is sometimes desirable to provide higher lighting levels at the teaching station. Lighting power density (LPD) levels should be no higher than 1.2 watts per square foot. The minimum illumination levels established for space types by the Illuminating Engineering Society of North America should be met.

Documentation for IEQ Prerequisite 3

1) Submit a lighting schedule for all lighting fixtures, including lamps and ballast information.
2) Submit plans showing the lighting layouts for the following spaces:
   - ❑ General classrooms
   - ❑ Science rooms
   - ❑ Computer rooms
   - ❑ Special needs, remedial, and collaborative space

Resources

Consortium for Energy Efficiency's (CEE), http://www.cee1.org/

Illuminating Engineering Society of North America, http://www.iesna.org/

Advanced Lighting Guidelines, New Buildings Institute, http://www.newbuildings.org/lighting.htm

IEQ Indoor Air Quality Category

Purpose: Achieve good indoor air quality to protect student and staff health, and improve performance and attendance.

IEQ Prerequisite 4: Meet ASHRAE Standard 62.1-2004

Required	**IEQ P 4.** Design ventilation systems to ASHRAE Standard 62.1-2004: Ventilation for Acceptable Indoor Air Quality.

Supplying fresh ventilation air to classroom areas is critical to the protection of good indoor air quality. Ensure that the ventilation system's outdoor air capacity can meet standards in all modes of operation.

Documentation for IEQ Prerequisite 4

Submit a letter signed by a licensed professional engineer (P.E.) certifying that the standards of ASHRAE Standard 62.1-2004 will be met on the project.

Resources

The American Society of Heating, Refrigerating and Air-Conditioning Engineers, http://www.ashrae.org/

IEQ Prerequisite 5: Provide Walk-Off System

Required	**IEQ P 5.** Provide a three-part walk-off system for all active entryways to capture dirt, particulates, and moisture before they enter the building. At active entrances, provide grills, grates, etc. to remove dirt and snow. If there is a vestibule, provide a drop-through mat system within the vestibule. Avoid drain pans and traps in the vestibule to prevent a build up of moisture during summer months. Inside the entranceway, provide walk-off mats. The recommended length of interior walk-off mats is 15 feet. Provide, at a minimum, an individual mat for classroom doors that exit directly to the outdoors.

Particles tracked into the school are one of the chief sources of contamination of carpets and floors. Research on school carpeting in particular shows that it can be a reservoir of pesticides, heavy metals, and dust tracked in on students' shoes.

The best way to keep the school free of dust, dirt, and contaminants is to prevent these unwanted items from entering the building in the first place. It is especially important to protect young school children since they are more likely to sit and play on classroom floors and therefore be more exposed to contaminants.

"Active" entrances are those points where students and staff members enter and exit the building from parking areas and vehicle drop off areas, and recreational areas.

Documentation for IEQ Prerequisite 5

1. Submit specifications for permanently installed entryway walk-off systems and walk-off mats.
2. Submit photographs showing location of grates, grills, and walk-off mats at all high volume entrances

IEQ Prerequisite 6: Drainage To Prevent Water Accumulation

Required	**IEQ P 6.** Prevent water accumulation by designing surface grades to slope away from buildings and building foundations in order to drain away water, snowmelt, and HVAC condensate to prevent the accumulation of water. Rain leaders and downspouts must be directed to filtration structures, storage, or rain gardens, or to daylight provided that surface drainage moves water away from buildings. Evaporative drip pans for HVAC condensate removal prohibited

Due to health risks that can be caused by mold and microbial growth, all surface grades, drainage systems, and HVAC condensate must be designed to prevent the accumulation of water under, in, or near buildings. Condensate systems that rely on gravity drainage are strongly preferred to systems that use pumps to move condensate due to the maintenance issues and energy costs associated with pump systems.

Documentation for IEQ Prerequisite 6

1) Submit site plan showing grading plan
2) Submit plan of condensate system including details of the drain traps and gravity drainage system
3) If installing unit ventilator systems with air conditioning equipment, provide specifications demonstrating that evaporation trays are not being used.

IEQ Prerequisite 7: Prevent Spray On Buildings

Required	**IEQ P 7.** Irrigation systems must be designed and installed so that they do not spray on buildings.

Irrigation systems that spray on buildings often cause structural damage and mold growth. Do not install irrigation systems in locations where they can spray directly on buildings.

Documentation for IEQ Prerequisite 8

Submit plan of irrigation system showing that sprinkler ranges do not intersect with buildings.

IEQ Prerequisite 8: Prevent Mold Problems During Construction

Required	**IEQ P 8.** During construction, meet or exceed the following minimum requirements to prevent the growth of mold and bacteria: • Keep building materials dry – wood, porous insulation, paper, and fabric, should be kept dry to prevent the growth of mold and bacteria. Cover these materials to prevent rain damage, and if resting on the ground, use spacers to allow air to circulate between the ground and the materials.

	• Replace any water-damaged materials, or dry within 24 hours, due to the possibility of mold and bacterial growth. Materials that are damp or wet for more than 24 hours may need to be discarded. • Immediately remove any materials showing signs of mold and mildew, including any with moisture stains, from the site and properly dispose of them. Replace moldy materials with new, undamaged materials. • Require that moisture sensitive materials be delivered dry and protected from the elements. • Allow for time in the construction schedule for materials to dry before they are enclosed.

Construction activities affect indoor air quality long after the building is occupied. Being careful to protect building materials from moisture and removing water-damaged materials are important practices in the prevention of mold in new buildings.

Plan for keeping moisture sensitive materials dry by having them delivered dry and wrapped in plastic and providing for weather-tight storage on the construction site.

Documentation for IEQ Prerequisite 8

1) Submit a copy of the bid specification section that mandates the protection of building materials from water damage.
2) Submit photographs of the construction site illustrating materials protection.

IEQ Prerequisite 9: Use IAQ Best Practices During Construction

Required	**IEQ P 9.** If the building or a portion of the building is to be occupied during construction, meet or exceed the Recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) *IAQ Guideline for Occupied Buildings Under Construction*, 1995, chapter 3.

Applicants shall implement containment procedures for dusts, gases, fumes, and other pollutants created during renovation/construction as part of any planned construction of, addition to, or renovation of a school building. Such containment procedures shall be consistent with the most current edition of the *IAQ Guidelines for Occupied Buildings Under Construction* published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA). All bids received for school construction or renovations shall include the cost of planning and execution of containment of construction/renovation pollutants consistent with the SMACNA guidelines. For occupied renovations, the plan shall include a complaint procedure and a system (bulletin, backpack letters, web site) for communicating information about procedures, protective measures, and construction schedules from the construction team to the building occupants.

Documentation for IEQ Prerequisite 9

Submit a Construction Indoor Air Quality Management plan that will address SMACNA "control measures" for IAQ such as HVAC system protection and equipment that emits exhaust. The plan should also address incorporation of low VOC products, depressurizing work areas, improved housekeeping, and scheduling of construction activity to lower impacts of IAQ on workers and potential building occupants, and method of communication between construction team and building occupants or vice versa, if it is an occupied renovation.

Resources

Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), http://www.smacna.org/

IEQ Prerequisite 10: Replace HVAC Filters Prior To Occupancy

Required	**IEQ P 10.** Replace all HVAC filtration media immediately prior to occupancy.

Dust and other contaminants during construction and final cleanup severely tax filtering systems. All filters must be replaced prior to occupancy of the building.

Documentation for IEQ Prerequisite 10

Submit a copy of the bid specification section that requires the replacement of filters prior to occupancy.

IEQ Prerequisite 11: Install HVAC MERV 10 Filters

Required	**IEQ P 11.** Ensure that permanently installed filtration media have a Minimum Efficiency Reporting Value (MERV) of at least 10 except for unit ventilator systems, which shall have a MERV of at least 7.

Documentation for IEQ Prerequisite 11

Specify replacement of filters with MERV 10 and, in unit ventilator systems, MERV 7. This documentation is unnecessary if IEQ Credit 3.3 for MERV 13 filters is fulfilled.

IEQ Prerequisite 12: Install Electric Ignitions

Required	**IEQ P 12.** Specify only electric ignitions for the following gas-fired equipment: water heaters, cooking stoves/ovens, air handling units, boilers.

Under certain conditions, the accumulation of carbon monoxide from pilot lights can cause dangerous air quality conditions for staff and students. Therefore, electric ignitions are required for the above listed equipment.

Documentation for IEQ Prerequisite 12:

Submit specifications for all gas-fired equipment.

IEQ Prerequisite 13: Properly Locate Air Intakes

Required	**IEQ P 13.** Locate outside-air intake openings a minimum of 25 feet from any hazard or noxious contaminants such as vents, chimneys, plumbing vents, exhaust fans, cooling towers, streets, alleys, parking lots, and loading docks. When locating an intake opening within 10 feet of a contaminant source is unavoidable, such opening shall be located a minimum of 2 feet below the contaminant source. This prerequisite is based on the BOCA 1993 Mechanical Code Section M-308.1.

Locating air intakes away from sources of potential air pollution will ensure that indoor air quality is not compromised by diesel fumes or ventilation, kitchen, or HVAC system exhausts. Locate air intakes at least 2 feet above grade and away from areas of potential snow buildup and away from plantings. Be particularly careful to locate air intakes away from areas where school buses and other vehicles may be idling. Consider prevailing winds and both current and future traffic and development patterns and consult the local board of health to locate nearby emission sources.

Documentation for IEQ Prerequisite 13

Provide drawings showing all air intake openings. Clearly identify hazardous and noxious contaminant sources on the drawings and bubble each air intake with a 50 ft. diameter circle (25 ft. radius) on the drawings.

Where intake openings front on a street or public way, measure the horizontal distance from the centerline of the street or public way to the air intake.

If an air intake is within 25 ft. of vents, chimneys, plumbing vents, exhaust fans, cooling towers, streets, alleys, parking lots, and loading docks, then show that it is at least 2 feet below the contaminant source and 10 feet away horizontally from the nearest edge of the air intake to the nearest edge of the contaminant source. Indicate the horizontal and vertical distances from the contaminant source in the drawings.

Resources

International Code Council, Building Officials and Code Administrators (BOCA), http://www.iccsafe.org/help/redirect-bocai.html

IEQ Prerequisite 14: Avoid Installing Internally Insulated Ductwork

Required	**IEQ P 14**. Do not install internally insulated ductwork unless it is double-walled ductwork or includes duct liners that meet ASTM standards C1071 and C1104 for surface erosion and water vapor sorption.

Duct insulation should be located on the outside of ductwork. Duct insulation found on the inside of ductwork has been known to deteriorate over time, leading to the distribution of particles into occupant area.

Documentation for IEQ Prerequisite 14

Submit the specifications for the project ductwork, including details of duct insulation and duct liners. If insulated ductwork has been specified for sound attenuation, explain where it will be used and how IAQ will be protected.

Resources

ASTM International, http://www.astm.org

IEQ Prerequisite 15: Do Not Use Fossil Fuel Powered Machinery whin the Building

Required	**IEQ P 15.** Prohibit fossil fuel powered mobile machinery from being used inside the building.

Prohibit mobile equipment inside the building that burns fossils fuels. This is to prevent accumulation of exhaust from equipment such as polishers, burnishers, material lifts, etc. Equipment such as gas stoves, chemistry equipment, and vocational equipment are not included in this requirement.

Documentation for IEQ Prerequisite 15:

Submit a letter signed by the school superintendent stating that no indoor mobile fossil fuel burning equipment will be used in the new or renovated facility.

IEQ Prerequisite 16: Meet ANSI Standards for Acoustical Performance

Required	**IEQ P 16.** Ensure that all classrooms meet the standards of ANSI 12.60-2002, the requirements of which include: • <35 dB background noise and maximum reverberation time of 0.6 seconds for areas =10,000 ft^2 • <35 dB background noise and maximum reverberation time of 0.7 seconds for areas >10,000 ft^2 and =20,000 ft^2 • <40 dB background noise for areas >20,000 ft^2

Student learning suffers in acoustically poor environments. Excess noise from exterior sources, loud HVAC systems, or other nearby rooms can make it difficult, and sometimes impossible, for students and teachers to communicate.

Poor acoustics affect more children than just those with permanent hearing impairments. Children with learning disabilities, language impairments, or for whom English is a second language, and children with ear infections are also adversely affected by poor acoustics. In addition, children in general (and especially younger ones in particular) have not fully developed their language and auditory skills, making quality acoustics very important for learning.

School officials and designers are strongly encouraged to move beyond the prerequisite and achieve background noise levels of NC30 (Noise Criteria) for all classrooms (approximately equivalent to 35 dBA) and sound isolation standards recommended by ANSI (the American National Standards Institute).

It may not be possible to reach NC30 with unit ventilator systems. Consider HVAC options that do not require unit ventilators. If you do opt for unit ventilators, however, it is important to select quieter models and/or those that can operate at low speeds.

Important aspects of classroom acoustical design include isolation from exterior noise (wind loads, traffic, and other loud outdoor activities), elimination of interior noise (from HVAC systems, foot traffic, and other classrooms), and the use of appropriate wall assembly, window systems, and interior surface materials to minimize sound propagation and reduce reverberation times in the classrooms.

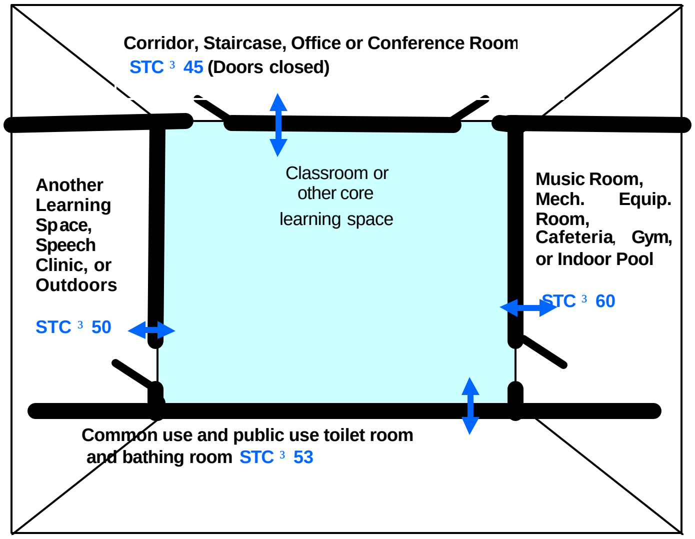
The most common sources of interior mechanical noise are the air-conditioning and air-handling systems, including ducts, fans, compressors, condensers, and dampers. The selection, location, and isolation of this equipment should be reviewed to minimize its impact on sound-sensitive spaces within school facilities.

For purposes of this prerequisite, classrooms are defined as:

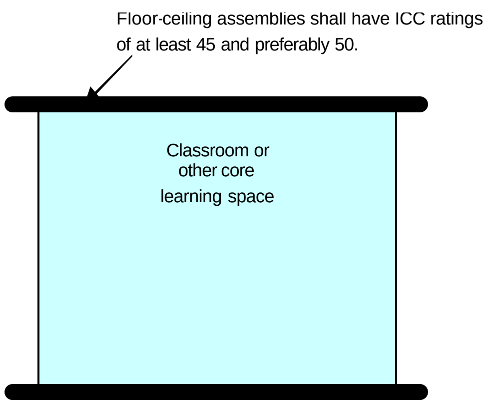
- ❑ General classrooms
- ❑ Art rooms
- ❑ Music rooms
- ❑ Science rooms
- ❑ Computer rooms
- ❑ Special needs, remedial, and collaborative space

The diagram below is a schematic representation of ANSI’s noise isolation requirements. Please consult the full ANSI standard for other details.

Noise Isolation (STC) Requirements



Noise Isolation (STC) Requirements (top view)



Impact Insulation Class (IIC) Rating (side view)

Source: CHPS, Inc. PowerPoint presentation – modified by MTC based on requirements in ANSI S12.60-2002.

Documentation for IEQ Prerequisite 16:

Submit a report from a qualified acoustical consultant verifying that classrooms have been designed to meet the relevant requirements.

Resources

National Clearinghouse for Educational Facilities, http://www.edfacilities.org/

Acoustical Society of America, http://asa.aip.org/ and http://asa.aip.org/classroom/booklet.html/

American National Standards Institute, http://www.ansi.org/

ANSI 12.60-2002 is available from for free download from the Acoustical Society of America at http://asastore.aip.org/shop.do?pID=109

Interactive Reverberation Test, http://www.armstrong.com/commceilingsna/article21088.html

IEQ Prerequisite 17: Provide For Thermal Comfort During the Heating Season

Required	**IEQ P 17.** Comply with ASHRAE Standard 55-2004 for thermal comfort standards during the heating season, within established ranges per climate zone.

Although this prerequisite does not require humidification and/or dehumidification systems, there are design choices such as direction of air supply and air supply velocity, which can affect the humidity levels experienced by occupants. When designing the layout of the HVAC system, humidity impacts should be considered.

Documentation for IEQ Prerequisite 17

Submit a letter signed by a licensed professional engineer (P.E.) certifying that the heating season comfort requirements of ASHRAE Standard 55-2004 will be met and outlining the design features relating to the standard.

Note: Compliance with ASHRAE Standard 55-2004 is also required for energy efficiency. Documentation for this requirement may address comfort issues only.

Resources

CHPS Best Practices Manual, vol. 2, "HVAC" chapter

ASHRAE Standard 62.1-2004, The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, http://www.ashrae.org/

International Code Council, Building Officials and Code Administrators (BOCA), http://www.iccsafe.org/help/redirect-bocai.html

IEQ Prerequisite 18: Adopt an Integrated Pest Management Program

Required	**IEQ P 18.** Adopt or develop an Integrated Pest Management program designed to exclude undesirable pests from the school buildings.

Integrated pest management (IPM) includes a set of techniques that are used to exclude pests from buildings and to destroy the habitat of pests by limiting their access to food, water, and free movement without dependence upon chemicals that are harmful to human health. Regular monitoring and record keeping is used to determine when treatments are needed to keep pest numbers low enough to prevent damage. Chemical controls are used only when necessary and in the least toxic formulations that are effective.

As discussed elsewhere in the Protocol, asthma is one of the most common chronic childhood ailments and is associated with frequent school absences among children. Insect and rodent allergens are known triggers for asthma, and pest infestation affects a range of other human health issues. In addition pest infestation can be damaging to building structure and systems.

Research demonstrates that the use of insecticides and rodenticides helps to limit infestations, but does not eliminate them. Over time, repeated application of pesticides may lead to resistance among targeted species, requiring greater amounts, or the use of more toxic materials to achieve the same effect.

A qualifying IPM program must include, at a minimum, the following measures:

- ❑ For all exterior walls, foundations, attics, roofs, utility chases, and interior partitions and ceilings in food storage, preparation and disposal areas, and penetrations:
- ❑ Block all openings in the enclosure larger than 1/4 inch by 1/4 inch with concrete or mesh reinforced caulk, or copper or stainless mesh or screen over openings that must allow air flow.
- ❑ Caulk all cracks larger than 1/16th inch, including all plumbing and electrical penetrations.
- ❑ Keep all shrubbery a minimum of 3 feet from the building structure.
- ❑ Utilize dumpsters and other rubbish containers that seal tightly and locate them as far away from the building as practicably possible.
- ❑ Do not allow debris to collect near doors and other building openings.
- ❑ Design building facades so that pigeons cannot roost.
- ❑ Maintain a schedule for the cleaning and degreasing of stoves, refrigerators, cabinets, floors, and walls in kitchens, bathrooms, teacher lounges, etc.
- ❑ Minimize the use of hazardous pesticides.
- ❑ Maintain a schedule and record of treatment.
- ❑ The adoption of the IPM methods detailed in the EPA's *IPM for Schools: A How-to Manual* is recommended. Appendix B of the manual provides a guide for the development of an IPM program. The manual may be downloaded free of charge from the following link: http://www.epa.gov/pesticides/ipm/schoolipm/index.html

Documentation for IEQ Prerequisite 18

1. Submit construction specifications that meet the above listed requirements for the sealing of penetrations, the design of building facades, and the location of shrubbery.
2. Submit an IPM plan or documentation that the school administration has adopted the EPA's *IPM for Schools: A How-to Manual* as the IPM plan, or another equivalent plan, for the school.

Resources

EPA: *IPM for Schools: A How-to Manual*
http://www.epa.gov/pesticides/ipm/schoolipm/index.html

State and Regional IPM Coordinators
http://www.epa.gov/pesticides/ipm/ipmcontacts.htm#region1

Indoor Environmental Quality Elective Credits

IEQ Elective Credit 1: Install Dedicated Exhaust For Pollutant Source Control

1 Credit	**IEQ EC 1.** Where chemical use occurs, including housekeeping areas, chemical mixing areas, copying/print rooms, photo-labs, science labs, and vocational spaces, use deck-to-deck partitions with dedicated exhaust at a rate of at least 0.50 cubic feet per minute per square foot with adequate make-up air. No air recirculation is permitted, and these spaces must have negative air pressure, which is defined as an outside exhaust at a rate of at least 0.50 cubic feet per minute per square foot, maintaining a negative pressure of at least 5 Pa (0.02 inches of water gauge) to a minimum of 1 Pa (0.004 inches of water) when the doors are closed. In photo-lab areas, specify table vents to draw chemical vapors away from the breathing zone of dark room users.

Physically isolate activities associated with chemical contaminants from other locations in the building and provide dedicated systems to contain and remove chemical pollutants from source emitters at source locations. Eliminate or isolate high hazard areas and design all housekeeping chemical storage and mixing areas (central storage facilities and janitors closets) to allow for secure product storage. Design copy/fax/printer/printing rooms with structural deck-to-deck partitions and dedicated exhaust ventilation systems.

Documentation for IEQ Elective Credit 1

1) Submit specifications for specialty exhaust ventilation equipment (e.g. table vents) and floor plans.
2) Submit a letter signed by a licensed professional engineer explaining how the spaces specified in IEQ Credit 1 are ventilated to maintain a 1–5 Pa negative pressure and exhaust rate of 0.50 cfm/ft^2.

IEQ Elective Credit 2: Install Ducted Air Returns

1 Credit	**IEQ EC 2.** Install ducted HVAC air returns to avoid the dust and microbial growth issues.

Plenum returns are easily contaminated with dust and microbial growth. Ducted returns help prevent such problems and reduce maintenance and repairs.

Documentation for IEQ Elective Credit 2

Submit drawings and specifications for HVAC system documenting the installation of ducted air returns.

IEQ Elective Credit 3: Install Premium HVAC Filtration

1 Credit	**IEQ EC 3.** Design the HVAC system with particle arrestance filtration rated at Minimum Efficiency Reporting Value (MERV) of 13 in all mechanical ventilation systems immediately prior to occupancy.

Filters rated at MERV 13 will ensure very good quality ventilation air by blocking minute particles and allergens.

The pressure drop may be greater with MERV 13 filters versus filters with lower MERV ratings, and therefore more energy is needed to draw air through these filters. There is often a trade off between incremental indoor air quality improvements and energy efficiency that design teams should bear in mind. This credit may be especially desirable in environments where outdoor air quality is a serious concern (e.g. close proximity to industrial activity, high vehicle traffic thoroughfares, or certain agricultural activities).

Note: MERV 13 filters do not fit into unit ventilators. Therefore, schools with unit ventilator systems cannot qualify for this credit.

Documentation for IEQ Elective Credit 3

Submit specifications for MERV 13 filters in all HVAC systems.

IEQ Credit 4: Provide Operable Windows

1 Credit	**IEQ EC 4.** Ninety percent (90%) of all classrooms shall have a minimum of one operable window per classroom that is reasonably accessible.

Operable windows are important for personal comfort and have been shown to improve student performance. Provide at least one operable window, reachable without a ladder, in each classroom.

Documentation for IEQ Elective Credit 4

Supply window specifications and floor plans highlighting operable windows in each classroom.

IEQ Elective Credit 5: Install High Intensity Fluorescent Lighting Systems in Gymnasiums and Other Locations with High Ceilings

1 Credit	**IEQ EC6.** Install high intensity fluorescent lighting fixtures instead of HID fixtures in the gymnasium and other high ceiling areas.

For many years, the standard choice for school gymnasiums, field houses, and other multi-use areas with ceilings over 16 feet high has been High Intensity Discharge (HID) lighting; typically metal halide or pulse-start metal halide. Although the technology is relatively efficient, long warm-up times mean that the lighting is typically turned on for the day. High intensity fluorescent lighting can be turned on and off as need, or it can be controlled by occupancy sensors. Additionally, the fluorescent fixtures offer higher quality light with better color stability and less ballast noise.

Documentation for IEQ Elective Credit 5

1) Submit plans showing the lighting layouts for the gymnasium and other applicable areas.
2) Submit a specification (cut) sheet for the fixtures being installed.

IEQ Elective Credit 6: Construction Management – Provide Ventilation

1 Credit	**IEQ EC 6.** Supply temporary construction ventilation. Continuously ventilate during installation of materials that emit Volatile Organic Compounds (VOCs) and after installation of those materials for at least 72 hours or until emissions dissipate. Ventilate directly to outside areas; do not ventilate to other enclosed spaces that are occupied by students, staff, or contractors. If continuous ventilation is not possible using open windows and temporary fans, then the building's HVAC system may be utilized provided that MERV 8 filtration media are installed at each return air grill as determined by ASHRAE 52.2-2004.

This construction practice will improve indoor air quality by minimizing the amount of indoor pollutants that are distributed and retained by the surface materials and ventilation systems during construction.

This credit is designed to protect the health of building occupants during and immediately following construction. It is not intended to replace OSHA requirements protecting the health and safety of construction workers.

Documentation for IEQ Elective Credit 6

Submit construction specifications showing that temporary ventilation will take place in accordance with the requirements of this credit

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IEQ Elective Credit 7: Construction Management – Protect Ductwork from Contamination

1 Credit	**IEQ EC 7.** During construction, seal HVAC supply and return openings to protect them from dust infiltration during such activities as drywall installation and floor sanding. If installing a new duct system, follow SMACNA guidelines "Duct Cleanliness for New Construction Guidelines" according to **advanced** levels of cleanliness. Of specific importance are the following: • Specify that ductwork be sealed during transport. • Store ductwork in clean, dry conditions and keep sealed. • Wipe down internal surfaces of ductwork immediately prior to installation. • Seal open ends of completed and "in-progress" ductwork. • During installation protect ductwork with surface wrapping.

This construction practice will improve indoor air quality by minimizing the amount of indoor pollutants that are distributed and retained by the surface materials and ventilation systems during construction.

Documentation for IEQ Elective Credit 7

Submit construction specifications for dust protection, referring to SMACNA Duct Cleanliness Guidelines Advanced Levels. Include specifications for removal (internal wipe-down) of oil film from ductwork.

IEQ Elective Credit 8: Construction Management – Provide for HEPA Vacuuming

2 Credits	**IEQ EC 8.** HEPA vacuuming: Vacuum carpeted and soft surfaces with a high-efficiency particulate arrestor (HEPA) vacuum prior to completion of construction. For phased, occupied renovations, HEPA vacuum the carpet daily in occupied areas.

This construction practice will improve indoor air quality by minimizing the amount of indoor pollutants that are distributed and retained by the surface materials and ventilation systems during construction. Additionally, materials such as carpet and textiles should be installed after dusty work like the sawing and sanding are complete. If some sawing and sanding is done after the textiles are installed it should done in containment and the textiles should be protected with sealed drop cloths.

Documentation for IEQ Elective Credit 8

Submit construction specifications for HEPA vacuuming of carpeted floors prior to full building occupancy. For phased, occupied renovations, obtain letter from Superintendent stating that carpeting in occupied areas of the school will be HEPA vacuumed daily

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IEQ Elective Credit 9: Construction Management – Perform Building Flushout

2 Credits	**IEQ EC 9.** Prior to flushout, filters must be replaced with at least Minimum Efficiency Reporting Value (MERV) 10 filters and replaced again after flushout with a minimum of MERV 10 filters. For unit ventilator systems, a minimum of MERV 7 filters must be installed and then replaced with MERV 7 filters after flushout. **AND** Perform one of two flushout options: Option 1 – The entire building shall be flushed out continuously (24 hours/day) with outside air for at least 10 days prior to receipt of certificate of occupancy. **OR** Option 2 – Flushing of each space may not begin until all major finish materials have been installed on floors, wall, and ceilings. This includes all casework. At that time, each space may be flushed out separately and occupied once 3,500 ft^3 of outdoor air per ft^2 of floor area of the space has been delivered. The space may then be occupied provided that it is

	ventilated at a rate of 0.30 cfm/ft^2 of outside air or the design minimum outside air rate, whichever is greater, a minimum of 3 hours prior to occupancy and during occupancy, until the total of 14,000 ft^3/ft^2 of outside air has been delivered to the space. NOTE: Option 2 is recommended if flush-out dates coincide with time periods when relative humidity levels are typically high (e.g., 70% or greater during hot, humid weather). Water vapor can warp wood and cause mold growth problems on building materials.

Building flushout removes odors and volatile organic compounds (VOCs) that accumulate during the construction process.

Use of outside air will prevent particles from continuing to recirculate throughout the building. Do not "bake out" the building by increasing the temperature of the space.

Documentation for IEQ Elective Credit 9

Submit construction specifications calling for installation of MERV 10 filtration media prior to building flushout and post flushout. MERV 7 filters are required for unit ventilator systems both prior and following building flushout.

AND

For Option 1 – A copy of the build-out schedule indicating when the 10 days of outdoor air flushout would begin.

For Option 2 – Submit calculations from the HVAC engineer showing:

1) The settings needed to provide 3500 ft^3/ft^2 of outside air to each space in the school
2) The amount of time the ventilation system needs to run for each space to reach the minimum threshold of 3500 ft^3/ft^2
3) The settings for delivering outside air at a rate of 0.30 cfm/ ft^2 of outside air or the design minimum outside air rate, whichever is greater
4) The amount of time the ventilation system needs to run for each space to reach the minimum threshold of 14,000 ft^3/ft^2

VI. Energy Efficiency

Purpose: To reduce environmental impacts and operational costs associated with consuming energy.

Summary Tables

Energy Efficiency Prerequisites

Required	**EE P 1 (A, B, or C). Energy Efficiency Standard:** Design a school that performs significantly better than schools built to current standard practice by designing **25% or more above the ASHRAE 90.1 – 2001 standard** using A) the prescriptive criteria established by the New Buildings Institute's *Benchmark: Energy Benchmark for High Performance Buildings*, B) the prescriptive approach outlined in the ASHRAE standards, or C) the "total building approach" outlined in the ASHRAE standards.
Required	**EE P 2.** Install a continuous air barrier and employ air sealing best practices to control air leakage.
Required	**EE P 3**. Employ best practice HVAC design techniques to improve system performance and meet ASHRAE Standard 55.
Required	**EE P 4**. Commission all energy using systems.
Required	**EE P 5.** Provide effective and complete training and documentation on the operation and maintenance of the building systems identified in the commissioning report.
Required	**EE P 6.** Participate in energy efficiency incentive and technical assistance programs that are available through applicable utility and governmental programs.

Energy Efficiency Elective Credits

1-4 credits	**EE EC 1 (A, B, or C).** Demonstrate superior energy performance beyond prerequisite EE P1.
1 credit	**EE EC 2.** In addition to meeting the classroom daylighting prerequisite, incorporate daylighting throughout the building and control at least 40% of the connected lighting load with automatic daylighting controls and/or hybrid occupancy/daylight controls.
1 credit	**EE EC 3.** Perform enhanced building commissioning employing a third party commissioning agent throughout the design and construction process.
1 credit	**EE EC 4.** Design 90% of permanent classrooms without air conditioning or minimize air conditioning loads in classrooms by installing low energy use comfort systems. Qualifying systems could include dehumidification, hot gas bypass systems, energy recovery ventilation, or other innovative approaches.
1 credit	**EE EC 5.** Install VAV system with variable speed drives on appropriate fans and motors. Control air volume in response to indoor air quality needs.
1 credit	**EE EC 6.** Install an energy management system (EMS) to monitor and trend the energy consumed throughout the school.
1 credit	**EE EC 7.** In addition to Credit 5, install a submetering system for lighting loads and plug loads, integrating the data collected from the submetering systems with the energy management system.

Energy-efficient schools cost less to operate, conserving valuable energy resources, and reduce environmental pollution. Each State in the Northeast has an energy efficiency codes that governs the minimum energy performance requirements for new buildings and renovations. These codes represent the worst performing buildings that can legally be built. Schools can easily be built, or renovated, to outperform these codes by considerable degrees.

High performance schools incorporate design features and systems that operate with minimal energy usage while providing superior performance. The buildings are well insulated and resist uncontrolled infiltration/exfiltration. In addition, heating, ventilation, and lighting systems provide premium efficiency and improved comfort levels.

Energy modeling is an effective tool for achieving energy savings and is a critical part of an integrated design approach. Various combinations of building systems can be modeled using specialized software to show performance calculations for different systems and design features. The most effective energy modeling is an interactive process whereby different combinations of measures, such as daylighting, HVAC systems controls, lighting systems and controls, and energy recovery equipment are modeled to determine the best performance and lifecycle cost.

Choosing the right contractors and effective construction management will assure that the design features get properly implemented as intended. Project owners should seek out contractors that have a working knowledge of advanced building techniques and premium efficiency systems.

Commissioning, maintenance, and training are critcal o the performance of the school and its systems and are key to maintaining energy efficiency. Commissioning involves a rigorous quality assurance program that ensures the building and its systems are built and operated as designed and that the school district receives the proper training and documentation needed to operate and maintain the building. No building can perform optimally without adequate maintenance. Training is critically important for maintenance staff to thoroughly understand how to maintain and operate the building systems. When staff turnover occurs, appropriate documentation must be on hand in order to train new team members.

Energy Prerequisite 1: Design a School That Performs Significantly Better Than Schools Built to Current Standard Practice

There are three acceptable methods for meeting this requirement:

EP1 Option A – Meet the "Required" Energy Efficiency Criteria of *Benchmark*

EP1 Option B – Demonstrate that the Design Outperforms the Prescriptive Criteria of ASHRAE 90.1 2001 by at Least 25%.

EP1 Option C – Using a Building Simulation Approach, Demonstrate that the Design Outperforms the "Building Performance" Criteria of the ASHRAE 90.1 2001 by at Least 25%.

Because the New Buildings Institute's *Benchmark: Energy Benchmark for High Performance Buildings* offers an integrated reference guide and criteria package, it is highly recommended that design teams and administrators utilize Benchmark as the methodology for meeting this prerequisite.

Energy Efficiency Prerequisite 1 Option A: Meet the "Required" Criteria of *Benchmark*

Required	**EE P 1A.** Meet all the criteria designated within the New Buildings Institute's *Benchmark: Energy Benchmark for High Performance Buildings* as "required," and comply with all of its relevant "acceptance criteria" listed in appendix A.

Benchmark: Energy Benchmark for High Performance Buildings is a set of building performance criteria that addresses many aspects of high performance buildings. The *Benchmark* reference manual was developed by the New Buildings Institute and the Wisconsin Energy Center (see “resources” for this section) to provide guidelines for the construction of individual high performance buildings and to serve as criteria for inclusion in high performance building programs such as the Northeast High Performance School Protocol.

Benchmark was designed so that buildings built to specific guidelines would outperform ASHRAE standard 90.1 2001 by 25%–30%. Buildings designed to these guidelines, will be considered, by default, to meet the energy efficiency requirements of the Protocol.

Documentation for Energy Prerequisite 1A

Following the guidelines established in appendix A of *Benchmark*, submit documentation detailing the energy performance features of the building that demonstrate compliance with the guidelines.

Energy Efficiency Prerequisite 1 Option B: Demonstrate That the Design Outperforms the Prescriptive Criteria of the ASHRAE 90.1 2001 by at Least 25%.

Required Alternate	**EE P 1B.** Demonstrate performance better than ASHRAE 90.1 2001 by a minimum of 25% in accordance with the prescriptive approach and criteria outlined in the code document

Each State in the Northeast has adopted a version of ASHRAE Standard 90.1 as the State Energy Code. In most cases the code refers to ASHRAE Standard 90.1 2001 or is a modified version of that standard. As a result, it can be assumed that the energy performance obtained through adherence to that standard has become standard practice throughout the region. Each version offers the choice of a “prescriptive” or a “total building performance” path for demonstrating compliance with the code. The prescriptive path consists of requirements that must be met for the building envelope, HVAC, and electrical systems. The same prescriptive methodology that is used to demonstrate compliance with the code may be used to demonstrate energy performance 25% better than the requirements of ASHRAE 90.1 2001.

Documentation for Energy Prerequisite 1B

1) Submit a narrative describing the energy performance features of the building detailing the design approaches that will result in performance at least 25% better than what is required by ASHRAE 90.1 2001.

2) Submit a ComCheck-EZ report that demonstrates performance at least 25% better than ASHRAE 90.1 2001.

Energy Efficiency Prerequisite 1 Option C: Using a Building Simulation Approach, Demonstrate That the Design Outperforms the "Total Building Performance" Criteria of the ASHRAE 90.1 2001 by at Least 25%.

Required Alternate	**EE P 1C.** Demonstrate performance better than ASHRAE 90.1 2001 by a minimum of 25% in accordance with the "total building performance" approach and criteria outlined in the code document.

As an alternative to the prescriptive approach, all ASHRAE 90.1 based codes offer the option of using a methodology that compares the annual energy usage of the proposed building with that of a similar building (baseline building) of the same type and size that meets the prescriptive requirements of the code. This is typically referred to as a "total building performance," "energy budget," or "systems analysis" approach. In order to utilize this approach, the building is modeled using a simulation tool that predicts the annual energy performance of the building on an hourly basis. This approach is time consuming and is typically used to demonstrate compliance for buildings with unusual and/or innovative design features.

Acceptable energy modeling software programs include: DOE-2, Visual DOE, PowerDOE, Energy Plus, and E-Quest.

Documentation for Energy Prerequisite 1C

Submit a narrative describing the energy performance features of the building being modeled. In addition, provide a full report detailing the results generated by the simulation tool for both the proposed building and the baseline building. If building modeling is used for code compliance, the energy code compliance documentation may be submitted.

Documentation should include:

1) Energy cost assumptions – Conversion factors to be used for electricity are: 3,412 Btu/kWh for site Btu's and 10,000 Btu/kWh for source Btu's
2) Facility and site description – narrative describing the type of construction, hours of operation, and size and configuration of building. Also describe the mechanical system, lighting system and equipment loads, domestic hot water system, and any renewable energy systems
3) Narrative summarizing the analysis methodology, the baseline design, and results of energy modeling
4) Table summarizing and comparing the differences between "as designed" case and the baseline case
5) Table summarizing the annual energy consumption for the design case and the base case (see template below)

Item	Annual Energy Consumption					
	Electricity	Natural Gas, Oil, Other	Total Site Btu	Total Source Btu	Total Energy Costs	CO_2 Emissions
	KWh	*therms, gallons, other*	*MM Btu*	*MM Btu*	*$*	*Metric Tons*

Design case						
Base case						
Savings						
% Savings						

6) Table summarizing cost savings (see template below). Use actual retail utility rate structures and schedules.

Measure	Units	Baseline Building	As Designed Building	Savings
Electricity consumption	KWh			
Electricity consumption/s.f.	kWh/s.f.			
Electricity cost	$			
Electricity cost/s.f.	$/s.f.			
Natural gas, oil or other fuel consumption	Therms, gallons, other			
Natural gas, oil or other fuel consumption/s.f.	Therms, gallons, other/s.f.			
Natural gas, oil or other fuel cost	$			
Natural gas, oil or other fuel cost/s.f.	$/s.f.			
Total site energy consumption	MMBtu			
Total site energy consumption/s.f.	MMBtu/s.f.			
Total site energy cost	$			
Total site energy cost/s.f.	$/s.f.			

7) An *electronic* version of all input and output data from the school building energy model must be submitted with the application for project certification.

8) Paper copies of each of the following energy modeling reports for both the base case and the as-designed case (These should also be made available to the school's facilities personnel as well):

   - ❑ **Building Energy Consumption per End Use (BEPU)** – This report shows annual building energy use according to energy type (electricity, natural gas, etc) and energy end use (lights, space heating, space cooling, fans, etc). The energy use should be shown in the actual units of consumption, such as kWh for electricity, therms for gas, etc. The DOE report that contains this information is called **BEPU**.

- **Building Energy Consumption per End Use (BEPS)** – This report is very similar to the **BEPU** report described above. The difference is that the values in this report are all converted into the same units (MBtu), allowing a direct comparison of end-use intensities.
- **Energy Cost Summary (ES-D or ES-E)** – This report summarizes the yearly energy consumption and cost for all utility rates that are defined for/applicable to the project (electric rate, gas rate, etc).
- **Summary of spaces occurring in the project (LV-B)** – This report provides a list of all the zones occurring in the model along with the assigned lighting wattage, number of people, equipment wattage, infiltration amount, square footage, and volume.
- **Building Peak Load components (LS-C) –** This report provides a breakdown of the building cooling and heating peak loads according to the source of the loads (walls, roof, windows, occupants, light, equipment, infiltration, etc). This report does not include the loads due to ventilation air.
- **Equipment Loads and Energy Use for Central Plant Components (PSC)** – This report would be required only for projects that include central plant equipment such as boiler(s) or chiller(s). For each central plant component this report provides annual heating and/or cooling load, the electrical and fuel consumption, and performance information in a bin format, including hours of operation at different part loads, and the total annual hours of operation.

(Examples of each of these reports are included in the Energy End Notes.)

Important: Conversion factors for electricity are: 3,412 Btu/kWh for site Btu's and 10,000 Btu/kWh for source Btu's.

Resources

ASHRAE Standard 90.1 and Energy Codes

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is an organization with the main goal of "advancing the arts and sciences of heating, ventilation, air conditioning, and refrigeration for the public's benefit through research, standards writing, continuing education, and publications." One of ASHRAE's principal activities is the publishing of standards that establish accepted practices and uniform methods of equipment rating for the HVAC industry.

ASHRAE Standard 90.1 provides minimum requirements for the design of energy efficient buildings. The standard was designed to be used as the basis for energy efficiency codes for the design and construction of new buildings and for major renovations. The first edition of ASHRAE Standard 90.1 was published in 1975. The standard is now updated every three years.

Standard 90.1 includes minimum efficiency provisions for design and installation in the areas of building envelope, HVAC, and electrical/lighting. Individual states may adopt 90.1 by reference or may develop a modified version of the standard for use as an energy efficiency code. In addition, 90.1 is the basis for the International Energy Conservation Code (IECC).

States in the Northeast have all adopted ASHRAE 90.1 1999 or 2001 by reference, or have developed a modified version of the two.

For information on ASHRAE and ASHRAE Standard 90.1, visit www.ashrae.org or call them at 1-800-527-4723.

For the current status of state energy efficiency codes, please visit http://www.bcap-energy.org/map_page.php

Benchmark: Energy Benchmark for High Performance Buildings by New Buildings Institute, Inc. 2005 edition, http://www.newbuildings.org.

ANSI/ASHRAE/IESNA Standard 90.1 – *Energy Standard for Buildings Except Low-Rise Residential Buildings*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, GA, 1999, 2001, 2004, http://www.ashrae.org.

ENERGY STAR – a federal-government-sponsored program helping businesses and individuals protect the environment through superior energy efficiency, http://www.energystar.gov/

Rebuild America – manages the Energy Smart Schools program, http://www.rebuild.org/sectors/ess/index.asp.

Energy Efficiency Prerequisite 2: Install Air Barrier and Employ Air Sealing Practices to Control Air Leakage

Required	**EE P 2.** Install continuous air barrier and employ air sealing best practices to control air leakage.

Benchmark: Energy Benchmark for High Performance Buildings incorporates criteria for air sealing of the building envelope. If utilizing one of the alternative methods for complying with EE Prerequisite 1, the following air sealing criteria, adopted from *Benchmark* and the Massachusetts Building Code, must be followed:

1) **Installation of Continuous Air Barrier:** The building envelope shall be designed and constructed with a continuous air barrier to control air leakage into, or out of the conditioned space. The air barrier shall have the following characteristics:
   - ❑ It must be continuous, with all joints made air-tight.
   - ❑ It shall have an air permeability not to exceed 0.004 cfm/ft2 under a pressure differential of 0.3 in. water.
   - ❑ It shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure. It shall not displace adjacent materials under full load.
   - ❑ It shall be durable and/or maintainable.
   - ❑ The air barrier shall be joined in an air-tight and flexible manner to the air barrier material of adjacent systems, allowing for the relative movement of systems due to thermal and moisture variations and creep. Connection shall be made between:

- Foundation and walls.
- Walls and windows or doors.
- Different wall systems.
- Wall and roof.
- Wall and roof over unconditioned space.
- Walls, floor and roof across construction, control and expansion joints.
- Walls, floors and roof to utility, pipe and duct penetrations.

2) **Air barrier penetrations:** All penetrations of the air barrier and paths of air infiltration and exfiltration shall be made air-tight.

3) **Fenestration and Doors:** Air leakage for fenestration and doors shall be determined in accordance with ASTM E 283 or NFRC 400. Air leakage shall be determined by an independent laboratory accredited by a nationally recognized accreditation organization and shall be certified by the manufacturer. Air leakage shall not exceed 1.0 cfm/ft^2 for glazed swinging entrance doors and for revolving doors, and 0.4 cfm/ft^2 for all other products under a pressure differential of 0.3 inches of water.

4) **Sealing of Recessed Lighting Fixtures:** When installed in the building envelope, recessed lighting fixtures shall meet one of the following requirements:
   - ❑ Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.
   - ❑ Type IC rated, in accordance with ASTM E 283 no more than 2.0 cfm air movement from the conditioned space to the ceiling cavity. The lighting fixture shall be tested at 75 Pa or 1.57 lbs./ft.^{2} pressure difference and shall be labeled.

5) **Sealing of Envelope Gaps and Cavities:** All gaps and cavities between rough framing and door and window heads, jambs, and sills shall be made air-tight, filled with insulation and covered with a vapor barrier meeting the criteria for vapor barriers.

Documentation for Energy Prerequisite 2

Submit plan details and specifications for air sealing demonstrating compliance with the above listed criteria.

Resources

Benchmark: Energy Benchmark for High Performance Buildings version 1.1 by New Buildings Institute, Inc. 2005 edition, http://www.newbuildings.org.

Massachusetts Building Code Chapter 13, www.state.ma.us/bbrs/energy.htm

Air Barrier Association of America, http://www.airbarrier.org/index_e.php

Energy Efficiency Prerequisite 3: Employ Best Practice HVAC Design Techniques

Required	**EE P 3.** Employ best practice HVAC design techniques to prevent the over-sizing of equipment, improve system performance and meet ASHRAE Standard 55.

Heating and cooling systems are often oversized due to "safety" factors included in the design practice. For optimum energy performance, HVAC systems should be sized to accurately meet the load of the building. "Rules of thumb" will not provide accurate system sizing.

When sizing the heating and cooling systems, perform load calculations using interior load assumptions that are consistent with sustainable design practices. This includes using the actual interior lighting loads as designed, accounting for the actual glazing characteristics, providing credit for displaced loads if displacement or underfloor systems are used, and base miscellaneous loads on field-verified measurements or field-based research rather than typical owner programming assumptions. Where not feasible, document the non-standard load assumptions for owner concurrence.

When sizing the fan and air distribution systems, document fan-sizing calculations with zone-by-zone load calculations. Perform calculations to determine critical path supply duct pressure loss. Compare fitting selections for oval duct where feasible to lower leakage and reduce pressure loss. Separate all fittings in medium and high–pressure ductwork by several duct diameters to reduce system effects wherever feasible. Where possible, provide automatic dampers on exhaust in lieu of barometric dampers to reduce fan power and increase barometric relief.

Perform a second set of calculations using part-load conditions (maximum *likely* load and/or standard operating conditions). This includes using benchmark data, average daytime temperatures and non-peak solar gain, and other assumptions to define part-load conditions for the heating and cooling system. Include diversity factors for interior loads and other factors that will allow proper assessment of part-load operation.

Describe the system operation at these conditions and describe features of the design that will facilitate efficient operation at these part-load conditions. Document how the system will deliver ventilation air, maintain comfort in accordance with ASHRAE Standard 55 and operate in an energy efficient manner.

Documentation for Energy Prerequisite 3

Submit documentation that shows the methodology for calculating peak load and partial load conditions.

Resources

Benchmark: Energy Benchmark for High Performance Buildings, version 1.1, New Buildings Institute, Inc. 2005 edition, http://www.newbuildings.org

ASHRAE standard 55, http://www.ashrae.org

Energy Efficiency Prerequisite 4: Commission All Energy Using Systems of the Building

Required	**EE P 4.** Commission all energy using systems, documenting that the following critical building systems have been tested prior to occupancy. • Lighting controls (daylight, occupancy, light switching). • HVAC systems (such as hot water systems, chilled water systems, central air systems, ventilation systems). • Domestic Hot Water Systems • Energy Management Systems

Purpose: Verify that fundamental building elements and systems are designed, installed, and calibrated to operate as intended, and provide for the ongoing accountability and optimization of building energy performance over time.

High performance buildings are healthy, efficient, environmentally sensitive structures whose performance can be significantly affected if the building has not been constructed or cannot be operated according to the designers' specifications. Commissioning is a rigorous quality assurance program administered by a knowledgeable third party that ensures the building performs as expected.

The following commissioning procedures are required:

1) **Engage a commissioning agent.** The commissioning agent (CA) directs the commissioning process and should be engaged as early in the design process as possible. The commissioning services must be performed by an independent third party, or performed under separate contract with a member of the design team. The agent may be hired by an entity other than the owner, such as the architect, engineering team, or construction manager, but must report simultaneously to the owner and the holder of the contract.
2) **Develop design intent and basis of design documentation.** The architect and the design engineer are the most appropriate people to create this document, which should list the owner's requirements and design intent for each of the systems or features to be commissioned. The CA must review this document and a copy shall be provided to the owner.
3) **Include commissioning requirements in the construction documents.** All commissioning requirements must be integrated into the construction documents to clearly specify the responsibilities and tasks to be performed. Of particular importance are the delineation of the contractors' responsibilities regarding documentation, functional performance testing, occupant and operator training, and the creation of the operations and maintenance manuals.
4) **Develop a commissioning plan.** The commissioning plan includes a list of all equipment and systems to be commissioned, delineation of roles for each of the primary commissioning participants, and details on the scope, timeline, and deliverables throughout the commissioning process.
5) **Perform a verification.** Verify installation, functional performance, training, and operations and maintenance documentation for each commissioned system and feature. This is the heart of the commissioning process.

6) **Complete a commissioning report.** The report must show that the building's systems have met the design intent and specifications, have been properly installed, are performing as expected, and that proper O&M documentation and training have been provided. The report should include a compilation of all commissioning documentation described in this credit, including complete functional testing results and forms and should note any items that have not been resolved at the time of the report is issued.
7) **Develop a system and energy management manual.** This manual is intended to improve and enhance the documentation of system intent and operation and to help the building owner continue to operate the building systems as efficiently and effectively as possible throughout the life of the facility. The manual should cover the operations and maintenance of all HVAC and lighting systems, and the facility staff should be trained in the use of the manual.

Documentation for Energy Prerequisite 4

Submit a commissioning report that documents the above required procedures.

Energy Efficiency Prerequisite 5: Train Building Operators in the Operations and Maintenance of All Energy Using Systems and Maintain Systems Documentation

Required	**EE P 5.** Provide effective and complete training and documentation on the operation and maintenance of the building systems identified in the commissioning report. Training programs for school maintenance staff, administrators, teachers, and other staff must be developed and completed. Training is an essential step to protect indoor air quality and maintain superior energy performance. Maintenance and record keeping must meet the requirements stated below.

The following requirements help ensure that the intended operational procedures of the energy using systems are well documented and provided to the appropriate facility staff. Additionally, the training of facility staff will assure that the critical importance of proper operations and maintenance is understood and that design goals are met. These requirements are often included in the contract with the third-party building commissioning agent.

1) **Compile Operations & Maintenance Manual:** Provide detailed operations and maintenance information for all equipment and products in use in the school and is specifically written for maintenance and facility staff.

2) **Create a short, classroom "user's guide":** Provide an explanation for teachers and administrative staff on how to operate their room lighting and HVAC systems.

3) **Conduct Operations & Maintenance Training:** Provide a short introduction for all school staff, and then feature a special hands-on workshop for facility and maintenance personnel. Training shall include the interaction of the equipment operating together as a system.

4) **Ensure that maintenance and record keeping on building occupancy shall include:**

   - ❑ The HVAC system shall be inspected at least annually, and problems found during these inspections shall be corrected within a reasonable time. Air conditioning systems shall be inspected twice each year – before the cooling season and again after the cooling season.

- Inspections and maintenance of the HVAC system shall be documented in writing. The facilities manager (or individual responsible for oversight of facilities maintenance and operation) shall record the name of the individual(s) inspecting and/or maintaining the system, the date of the inspection and/or maintenance, and the specific findings and actions taken. The facilities manager shall ensure that such records are retained for at least five years.
- Calibrations of all sensors that are part of the HVAC system on a routine basis including CO_2 sensors for CO_2 demand controlled ventilation. Sensors shall be calibrated by experts such as controls contractors.

Documentation for Energy Prerequisite 5

Submit documents detailing the following:

- The training plan for the maintenance staff
- The plan for a "users" workshop for teachers and other staff members
- A description of the operations and maintenance manuals for maintenance staff including the identification of the personnel who will maintain the documents
- A schedule for the periodic testing of HVAC systems and the testing/calibration of HVAC and lighting controls

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Energy Efficiency Prerequisite 6: Participate in Utility and Governmental Energy Efficiency Incentive and Technical Assistance Programs

Required	**EE P 6.** Participate in energy efficiency incentive and technical assistance programs that are available through applicable utility and governmental programs.

Virtually every utility customer in the Northeast region is eligible to participate in at least one, and typically several, energy efficiency programs. The programs offer either technical assistance or incentives for efficient equipment and practices. Many programs offer both technical assistance and financial incentives for the installation of efficient equipment and the incorporation of efficient design practices.

In addition to utility and state government operated programs, beginning in 2006, the Federal Government is offering a tax credit program that will allow the designers of energy efficient public buildings to apply for a tax credit to help offset the costs of the design and construction of efficient buildings.

Participation in these programs, not only leads to possible financial incentives, but often provides valuable information regarding best practices in the local area, and local expert design and consultation services. School administrators should contact their electric and gas utility companies as well as their state energy office for specific program information.

Documentation for Energy Prerequisite 6

Submit copies of utility and/or governmental program documents that demonstrate participation in available energy efficiency programs.

Resources

Cape Light Compact, http://www.capelightcompact.org/

Connecticut Light and Power, http://www.cl-p.com/

Efficiency Maine, http://www.efficiencymaine.com/

Efficiency Vermont, http://www.efficiencyvermont.com/pages/

National Grid. http://www.nationalgridus.com/

NSTAR Electric, http://www.nstaronline.com/business/

Public Service of New Hampshire, http://www.psnh.com/

United Illuminating, http://www.uinet.com/

Western Mass Electric, http://www.wmeco.com/

Energy Efficiency Elective Credits

Energy Efficiency Elective Credit 1: Demonstrate Superior Energy Performance

Integrate the design of all significant building systems including HVAC, lighting, and building envelope to reduce source energy of the proposed design below what is required by the prerequisites of this Protocol.

1 credit	**EE EC 1A.** Demonstrate a 30% reduction in total net energy use compared to ASHRAE Standard 90.1 2001.

OR

2 credits	**EE EC 1B.** Demonstrate a 40% reduction in total net energy use compared to ASHRAE Standard 90.1 2001.

OR

4 credits	**EE EC 1C.** Demonstrate a 50% reduction in total net energy use compared to ASHRAE Standard 90.1 2001.

The credits offered in this section are in addition to the Energy Efficiency Prerequisites listed in this section. However, documenting compliance with this section may also serve as the documentation for meeting the requirements for prerequisite EP 1. To obtain credit, the school must achieve at least 30% less energy usage than a similar building that meets the requirements of ASHRAE Standard 90.1 2001.

Calculations for this credit may be made using the prescriptive methods or the “total building performance/energy cost budget” methodology allowed by the ASHRAE 90.1-2001 standard.

Documentation for Energy Elective Credit 1

The same methodologies and documentation (prescriptive or building modeling) required for Energy Efficiency Prerequisite 1 must be used to document eligibility for this credit.

Energy Efficiency Elective Credit 2: Incorporate Daylighting and Control At Least 40% of the Connected Lighting Load with Automatic Daylighting Controls and/or Hybrid Occupancy/Daylight Controls

1 credit	**EE EC 2.** In addition to meeting the classroom daylighting prerequisite, incorporate daylighting throughout the building and control at least 40% of the connected lighting load with automatic daylighting controls and/or hybrid occupancy/daylight controls.

Daylighting improves the indoor environmental quality, improving teacher and student performance. For these reasons, daylighting requirements are included in the IEQ section of the Protocol.

Daylighting also offers opportunities for energy savings. Where significant daylighting is available, automatic daylight harvesting controls should be used to turn the lights off or dim the lights when sufficient natural light is available. Classrooms, offices, gymnasiums, cafeterias, libraries, lobbies, and corridors are all areas that can benefit from automatic daylight harvesting systems. Classrooms and offices will also have occupancy controls to meet the relevant energy code and the prerequisites of this protocol. Hybrid sensors that control the lighting for both occupancy and daylight are available, as are integrated systems that use both individual occupancy and daylight sensors. It is critically important that these systems be properly adjusted during the building commissioning process.

Documentation for Energy Elective Credit 2

Submit a narrative description of the daylighting system, detailing the areas that are to be daylit and the control system being installed. Provide a lighting controls schedule and electrical/lighting plans illustrating the control systems and the lighting fixtures that they will control.

Energy Efficiency Elective Credit 3: Perform Enhanced Building Commissioning

1 credit	**EE EC 3.** Perform enhanced building commissioning employing a third party commissioning agent throughout the design and construction process.

Note: Meeting and documenting the requirements of this credit also serves as the documentation for complying with the building commissioning Prerequisite EE P3.

This credit expands the role of the CA to include review of the design, construction documents, and submittals beyond the tasks required by Prerequisite E P 4.1. In addition, the CA must develop and provide a system and energy management manual to help school staff understand the equipment and operating procedures. The commissioning services must be performed by an independent entity – one that is separate from both the design firm and the contractors. For continuity in the commissioning process, it is recommended that the same agent be selected to perform all commissioning-related tasks.

In order to qualify for this credit, the following tasks must be performed and documented in the commissioning report.

1. **Conduct a focused review of the design prior to the construction documents phase.** This review early in the design process should be focused on an assessment of how well the design meet's the owner's design intent. Assessment should be made as to how the design meets the functionality, utility performance, maintainability, sustainability, cost, and indoor environmental quality requirements outlined in the design intent.

2. **Conduct a focused review of the construction documents.** This review should be conducted prior to issuing the construction documents for bid. This review should answer these questions:
   - ❑ Does the design meet the owner's design intent?
   - ❑ Does the design allow for proper maintenance access?
   - ❑ Do the construction documents clearly detail the construction requirements?
   - ❑ Do the construction documents clearly define the commissioning requirements?

3. **Conduct a selective review of contractor submittals of equipment to be commissioned.** Contractor submittals for the systems and equipment included in the commissioning scope shall be reviewed by the CA in conjunction with the designer's review. The review shall focus on the ability of the submitted product to meet the owner's requirements and review comments shall be provided to the owner and the design team.

4. **Develop a system and energy management manual.** This manual is intended to improve and enhance the documentation of system intent and operation and to help the building owner continue to operate the building systems as efficiently and effectively as possible throughout the life of the facility. The manual should cover the operations and maintenance of all HVAC and lighting systems, and the facility staff should be trained in the use of the manual.

5. **Conduct a near-warranty end, or post-occupancy, review.** This review is intended to bring the design, construction, commissioning and O&M staff together to solicit the O&M staff comments, suggestions, and areas of concern regarding the systems in their first year of operation. Any warranty items should be identified and a plan for resolution developed.

Documentation for Energy Elective Credit 3

Submit a copy of a signed commissioning services contract documenting that the commissioning agent will:

- ❑ Conduct a focused review of the design prior to the construction documents phase
- ❑ Conduct a focused review of the construction documents when close to completion
- ❑ Conduct a selective review of contractor submittals of commissioned equipment
- ❑ Develop a system and energy management manual

- ❑ Conduct a near-warranty end, or post-occupancy, review.

Resources

CHPS Best Practices Manual, vol. 2, Guideline GC5: Contractor's Commissioning Responsibilities, http://www.chps.net/

ASHRAE Guideline 1-1996: *The HVAC Commissioning Process* and ASHRAE Guideline 4-1993: *Preparation of Operations & Maintenance Documentation for Building Systems*, http://www.ashrae.org.

LEED Reference Guide, Energy and Atmosphere, U.S. Green Building Council, http://www.usgbc.org/

Energy Efficiency Elective Credit 4: Minimize Air Conditioning

1 credit	**EE EC 4.** Design 90% of permanent classrooms without air conditioning or minimize air conditioning loads in classrooms by installing low energy use comfort systems. Qualifying systems could include dehumidification, hot gas bypass systems, energy recovery ventilation, or other innovative approaches.

For this credit, classrooms are defined as:

- ❑ General classrooms
- ❑ Art rooms
- ❑ Music rooms
- ❑ Science rooms
- ❑ Special needs, remedial, and collaborative space

Documentation for Energy Elective Credit 4

Submit HVAC drawings and a narrative describing the approach and operational sequence of the proposed system.

Energy Efficiency Elective Credit 5: Install Variable Air Volume (VAV) System with Variable Speed Drives

1 credit	**EE EC 5.** Install VAV system with variable speed drives on appropriate fans and motors. Control air volume in response to indoor air quality needs.

School buildings require abundant amounts of fresh air in order to maintain indoor air quality. If the air volume is not carefully controlled, energy will be wasted needlessly conditioning excess fresh air.

To qualify for this credit, a VAV system must be installed that responds to indoor air quality through the use of CO^2 sensors or other air quality monitoring systems. Fans 5 hp and greater associated with this system are to be controlled by variable speed drives that respond to the air quality and thermal comfort needs. Additionally, pumps associated with the HVAC system are to use variable speed drives to regulate flow.

"Displacement" ventilation systems that are responsive to indoor air quality demands may also be submitted for this credit.

Systems that simply monitor temperature are not eligible for this credit.

Documentation for Energy Elective Credit 5

Submit HVAC design document complete with pump, fan, and controls schedules, along with a "sequence of operations" document.

Resources

NBI Advanced Buildings Guidelines Reference Manual,
http://www.poweryourdesign.com/refguide.htm

Energy Efficiency Elective Credit 6: Install Energy Management System

1 credit	**EE EC 6.** Install an energy management system (EMS) to monitor and trend the energy consumed throughout the school by the following systems: • HVAC (heating, cooling, fans) • Domestic/process hot water systems

While energy management systems (EMS) are typically installed with new HVAC and heating systems, care must be taken to specify and install an appropriate system for the school. The best EMS is often the simplest system that still addresses the school's energy management needs. Increased complexity does not always mean increased value.

With the installation of EMS, proper training of maintenance staff is absolutely critical. The district must be prepared to budget for training both existing staff and new staff hired when those knowledgeable about the EMS leave employment.

Monitoring capabilities of the EMS should allow for comparison between various types of building loads throughout all spaces of the school. This information can be used to manage and optimize energy use.

The EMS should comprise, at a minimum, the following:

1) Sensors – provided as follows:

- ❑ Sensors to monitor and trend (create trend logs) controlled variables at the operator interface. Control variables may include air and/or water flow, temperature, pressure, CO_2, and pump or fan speed.
- ❑ Sensors to trend outdoor air temperature.
- ❑ Sensors to monitor and trend equipment status for all equipment with motors greater than 1/2 hp.

- ❑ Indication and trending of damper and valve commanded position.
- ❑ Sensors to monitor building electrical, natural gas, and heating oil demand and consumption.
- ❑ Sensors to monitor indoor and outdoor CO_2.
- ❑ Relevant multiplexed data from microprocessors located in chillers, boilers, humidifiers, VAV box controllers, variable speed drives, and other HVAC equipment with multiplexing capabilities may be used in lieu of specifying separate sensors.
- ❑ Wells and other ports shall be specified for the installation of calibration devices to facilitate calibration of sensors.

Exceptions:

- ❑ Unit heaters, cabinet heaters, radiation and convectors located in vestibules, storage rooms, janitor closets, and other unoccupied areas.
- ❑ Natural gas and heating oil demand sensors are not required on buildings less than 50,000ft^2.

2) Points Matrix: A *points matrix* including all hardwired input and output devices connected to the automation system, all set points, upper and lower control limits.
3) Trend Capabilities: *Trend requirements* including a trend point list and preprogrammed sample of point (performed by controls contractor), sample rate, storage interval, upload interval, custom trend abilities, alarms, and automated trend data review and notification (automated diagnostics).
4) System Architecture: A *system architecture* capable of allowing sampling of these points to facilitate building commissioning and diagnostics without significantly affecting system performance.
5) Data Storage: A *data storage system* with adequate capacity to record trend data for use by building operators. Data export requirements must facilitate user-friendly data access and manipulation.
6) Operator Interface: An *operator interface* designed for remote/web access, monitoring requirements, trend-log reporting and diagnosing building problems through a user-friendly interface. This includes providing a visual (non-text based) operations and reporting interface to facilitate rapid system assessment that utilizes color coding, diagrams of floor plans and graphing capabilities.

Source: Advanced Buildings E-Benchmark Version 1.0, 2003 by the New Buildings Institute, Inc. pp.28-29.

Documentation for Energy Elective Credit 6

1) Submit design specifications that demonstrate compliance with the above listed requirements.
2) Submit a training plan that includes: who will be trained on the EMS; who will do the training; and plans for continued training in case of staff turnover.
3) Submit a list of personnel who have completed initial EMS training.
4) Submit a plan for the collection of trend-logging data.
5) Submit a plan explaining how the data collected from the system will be used for improving

the efficiency and maintenance of the HVAC and hot water systems.

Energy Efficiency Elective Credit 7: Install Submetering System

1 credit	**EE EC 7.** In addition to Credit 5, install a submetering system for lighting loads and plug loads, integrating the data collected from the submetering systems with the energy management system.

Submeter the lighting and plug loads allowing those loads to be monitored and controlled by the energy management system. Develop a plan for using the submetered data to expand the ability of the energy management system to improve energy efficiency.

Documentation for Energy Elective Credit 7

Submit the specifications for the submetering systems including the points that will be picked up by the EMS. Submit a plan explaining how the EMS will be used to reduce the energy usage of the lighting and plug loads. The documentation may be included as part of the documentation required for Credit 5 (above).

VII. On-Site Renewable Energy

Purpose: To promote the use of renewable energy technologies as a local generation source.

Summary Table

Renewable Energy Elective Credits

1-2 credits	**RE EC 1 (A, B).** Install on-site solar thermal energy system.
1-4 credits	**RE EC 2 (A, B, C, D).** Install on-site photovoltaic system.
1-4 credits	**RE EC 3 (A, B, C, D).** Install on-site wind energy system.
2-3 credits	**RE EC 4 (A, B).** Install on-site biomass energy system.
1-5 credits	**RE EC 5.** Install on-site renewable energy system other than the types listed for credits RE EC 1-4.

On-site alternative energy has many benefits. Alternative energy sources such as photovoltaics, solar thermal, and wind turbines use the sun and wind instead of non-renewable, polluting sources, such as coal, oil, or natural gas. Producing energy on-site also eliminates the environmental impacts of transmission losses associated with remote sources and transportation emissions associated with fuel delivery. On-site sources can be very effective components of school curricula, educating students on a wide variety of energy and science issues. And, on-site alternative energy production has the added advantage of increasing fuel diversity. Utilizing indigenous resources such as woody biomass, biogas, wind and solar energy is increasingly important as Northeast is rapidly becoming dependent upon natural gas.

School Energy Use Distribution – "Cold and Humid" Climate Zone

Source: *Energy Design Guidelines for High Performance Schools: Cold and Humid Climates*, US DOE, Office of Building Technology.

Renewable Energy Elective Credits

Renewable Energy Elective Credit 1: Install Renewable Solar Thermal Energy System

1 credit	**RE EC 1A.** Install on-site solar thermal energy system to meet 1% of the total building energy consumption, or 10% of the domestic hot water heating consumption.

OR

2 credits	**RE EC 1B.** Install on-site solar thermal energy system to meet at least 2% of the total building energy consumption or 20% of the domestic hot water heating consumption.

With the popularity of photovoltaic solar systems, it is often forgotten that solar thermal systems often offer the best investment in solar energy. Meeting a portion of the building's space heating, domestic water heating, or both loads combined is possible with a variety of system types and configurations. Systems dedicated to domestic water heating needs are often a good choice, as there is a demand for hot water year round, whereas space-heating needs are encountered for only a portion of the school year.

Documentation for Renewable Energy Elective Credit 1

1) Submit design specifications detailing all aspects of the system being installed.
2) Using the same calculations or calculation methodology used for the energy efficiency requirements of the Protocol, demonstrate that the installed system will supply the required percentage of the load according to the credit being sought.
3) Submit a plan for providing student and community education associated with the renewable energy project.

Renewable Energy Elective Credit 2: Install Renewable Solar Photovoltaic Energy System

1 credit	**RE EC 2A.** Install on-site photovoltaic system to either meet 1% of the school's energy loads, or produce a minimum of 2 kW of electricity.

OR

2 credits	**RE EC 2B.** Install on-site photovoltaic system to meet 3% of the school's energy loads.

OR

3 credits	**RE EC 2C**. Install on-site photovoltaic system to meet 5% of the school's energy loads.

OR

4 credits	**RE EC 2D.** Install on-site photovoltaic system to meet 10% of the school's energy loads.

Photovoltaic systems collect solar energy and directly convert it to electricity. The electricity generated is direct current (DC) and is either used to power DC devices or, more commonly, is converted (inverted) to alternating current (AC) to be used on-site for AC devices and/or supplied to the local electrical grid. Building and ground mounted systems are available.

Net-Metering – Most electric utilities throughout the region maintain net-metering programs for qualifying renewable energy systems. Under net metering, the output of such a system is either consumed immediately by the loads active within the building or sent to grid, spinning the electric meter backwards and effectively avoiding purchases of electricity from the utility at its retail rates. This is particularly helpful for wind and photovoltaic systems, which have variable and intermittent outputs.

Documentation for Renewable Energy Elective Credit 2

1) Submit design specifications detailing all aspects of the system being installed.
2) Using the same calculations or calculation methodology used for the energy efficiency requirements of the Protocol, demonstrate that the installed system will supply the required percentage of the load according to the credit being sought.
3) Submit a plan for providing student and community education associated with the renewable energy project.
4) Submit a net-metering agreement with the electrical supplier. If net-metering is not to be used, submit a plan for the effective use of the generated electricity.

Renewable Energy Elective Credit 3: Install Renewable Wind Energy System

1 credit	**RE EC 3A.** Install on-site wind energy system to either meet 1% of the school's energy loads, or produce a minimum of 2 kW of electricity.

OR

2 credits	**RE EC 3B.** Install on-site wind energy system to meet 3% of the school's energy loads.

OR

3 credits	**RE EC 3C.** Install on-site wind energy system to meet 5% of the school's energy loads.

OR

4 credits	**RE EC 3D.** Install on-site wind energy system to meet 10% of the school's energy loads.

Wind energy has been rapidly gaining in popularity, and many European countries now meet significant portions of their electrical needs with wind generators. Today's slow rpm generators have solved many of the maintenance concerns and have greatly reduced the negative effects on bird life.

The siting of wind generators is a long-term process, so planning must begin early. It is not unusual for the available wind to be monitored for a two-year period before selecting a site. Additionally, community aesthetic concerns often come into play when siting wind turbines.

Like photovoltaic systems, the energy generated may be used exclusively on-site or may be net-metered. Please see the photovoltaic section for a discussion of net metering.

Documentation for Renewable Elective Credit 3

1) Submit design specifications detailing all aspects of the system being installed.
2) Using the same calculations or calculation methodology used for the energy efficiency requirements of the Protocol, demonstrate that the installed system will supply the required percentage of the load according to the credit being sought.
3) Submit a plan for providing student and community education associated with the renewable energy project.
4) Submit a net-metering agreement with the electrical supplier. If net-metering is not to be used, submit a plan for the effective use of the generated electricity.

Renewable Energy Elective Credit 4: Install Renewable Biomass Energy System

2 credits	**RE EC 4A.** Install on-site biomass energy system to meet 10% of the school's total energy load or 75% of the heating load.

OR

3 credits	**RE EC 4B.** Install on-site biomass energy system to meet 20% of the school's energy load or 100% of the heating load.

Qualifying biomass energy systems utilize locally available renewable biomass fuels to supply heat and/or generate electricity. Waste wood products and/or wood products from sustainable practices are eligible fuel sources for qualifying systems. Depending on the project's location, a variety of state, federal, and local regulations must be met, therefore planning for biomass systems must start early.

Documentation for Renewable Elective Credit 4

1) Submit design specifications detailing all aspects of the system being installed.
2) Using the same calculations or calculation methodology used for the energy efficiency requirements of the Protocol, demonstrate that the installed system will supply the required percentage of the load according to the credit being sought.
3) Submit a plan for providing student and community education associated with the renewable energy project.
4) If the system will generate electricity, submit a net-metering agreement with the electrical supplier. If net-metering is not to be used, submit a plan for the effective use of the generated electricity.

Renewable Energy Elective Credit 5: Install Unlisted Renewable Energy System

1-5 credits	**RE EC 5.** Install on-site renewable energy systems other than the types listed for credits EC 1-4 in this section.

Besides the systems listed in this section, there are other possible alternatives for on-site renewable energy production. Systems that may be eligible for credit include, but are not limited to:

- Micro-hydroelectric
- Biogas
- Biodiesel
- Landfill gas

This credit is available on a “custom” basis. The amount of the credit and the documentation required will be determined by the administrators of the Protocol.

Documentation for Renewable Elective Credit 5

Early in the design process, submit a plan for the construction and operation of the proposed renewable energy system. Further documentation will be determined following the initial submission.

Resources

CHPS Best Practices Manual, vol. 2: Guideline OS1, http://www.chps.net/

LEED Reference Guide, Energy and Atmosphere Credit 2: Renewable Energy http://www.usgbc.org/

Advanced Buildings Reference Guide: Renewable Energy, http://www.poweryourdesign.com/refguide.htm

VIII. Water Efficiency

Purpose: To promote the efficient and responsible use of water resources.

Summary Tables

Water Efficiency Prerequisites

Required	**WE P 1.** Employ strategies that, in aggregate, reduce potable water use by 20% beyond the baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992's fixture performance requirements.

Water Efficiency Elective Credits

1 credit	**WE EC 1.** Refrain from installing permanent potable water irrigation systems for watering **non-playing-field** landscaped areas **AND** specify drought resistant plants or grasses in these areas so that irrigation is not needed at all.
1–2 credits	**WE EC 2 (A, B).** Reduce or eliminate potable water consumption for irrigation of athletic fields.
1 credit	**WE EC 3.** Create an irrigation commissioning plan followed by installation review during construction, performance testing after installation, and documentation for ongoing operations and maintenance.
2 credits	**WE EC 4.** Install a rainwater collection and storage system to be used for sewage conveyance and/or to irrigate the playing fields when no potable water is to be used.
1 credit	**WE EC 5.** Reduce water usage for sewage (blackwater) conveyance by a minimum of 50% through the utilization of water efficient fixtures and/or rainwater catchment systems.
1-3 credits	**WE EC 6.** Employ strategies that reduce potable water use by a minimum of 30% beyond the baseline calculated for the building.

Water Efficiency Prerequisite 1: Reduce Total Interior Water Usage

Required	**WE P 1.** Employ strategies that, in aggregate, reduce potable water use by 20% beyond the baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992's fixture performance requirements.

This prerequisite involves reductions in total water use; therefore all water uses are included in the calculations. To quantify water use reductions, use spreadsheets in the Application Template showing baseline and design water uses. List each water-using appliance or fixture, the amount of daily uses, number of occupants, and total water use. A water-efficient design for the school shown in the previous example is shown below.

Develop a water-use baseline including all water-consuming fixtures, equipment, and seasonal conditions according to methodology outlined below. Specify water-conserving plumbing fixtures that exceed the Energy Policy Act (EPAct) of 1992's fixture requirements in combination with ultra high efficiency or dry fixture and control technologies. Specify high water efficiency equipment (e.g., dishwashers, faucets, cooling towers).

Table 1 – Design Indoor Water Consumption Calculation

Fixture Type	Flow-rate	Duration	Occupants	Daily uses	Water use
Low-flow toilet (male)	1.6 gal/flush	1 flush	500	1	800
Waterless urinal (male)	0.0 gal/flush	1 flush	500	2	0
Low-flow toilet (female)	1.6 gal/flush	1 flush	500	3	2400
Bathroom sink	0.5 gal/min	0.17 min	1000	3	255
Low-flow shower	1.8 gal/min	5 min	100	1	900
Low-flow kitchen sink	1.8 gal/min	45 min	2	2	324
Efficient clothes washer	20 gal/load	1 load	-	10	200
				Total Daily Volume	4879
				Number of School Days	180
				Subtotal	878,220
				Minus Collected Rainwater	(396,000)
				Design Total Annual Volume	482,220

For the baseline calculation, create a similar spreadsheet but change only the type of fixture and its associated design details. The baseline calculation for this example would therefore be:

Table 2 – Baseline Indoor Water Consumption Calculation

Fixture Type	Flow-rate	Duration	Occupants	Daily uses	Water use
Conventional toilet (male)	1.6 gal/flush	1 flush	500	1	800
Conventional urinal (male)	1.0 gal/flush	1 flush	500	2	1000
Conventional toilet (female)	1.6 gal/flush	1 flush	500	3	2400
Bathroom sink	0.5 gal/min.	0.5 min	1000	3	750
Conventional shower	2.5 gal/min	5 min	100	1	1250
Kitchen sink	2.5 gal/min	45 min -	2	2	450
Clothes washer	40 gal/load	1 load -	-	10	400
				Total Daily Volume	7,050
				Number of School Days	180
				Baseline Total Annual Volume	1,269,000

Comparing the two spreadsheets, the water-efficient fixtures reduced potable water use by:
% Savings = 1 – (Design Total Annual Volume / Baseline Total Annual Volume)
= 1 – (482,220/1,269,000) = 0.62 = 62%
Therefore, this design would qualify because overall potable water use has been reduced by over 20%.

Documentation for Water Efficiency Prerequisite 1

1) Perform calculations as outlined above using the Application Template.
2) Submit specification section on plumbing fixtures. Be sure that the flow rates calculated in the template actually match the fixtures that have been specified in the bid documents.
3) Submit complete plumbing fixture schedule

Resources

LEED Reference Guide, Water Credit 2: Innovative Waste Water Technologies, http://www.usgbc.org/

Water Efficiency Elective Credits

Water Efficiency Elective Credit 1: Eliminate Irrigation for Non-Playing-Field Landscaping

2 credits	**WE EC 1.** Refrain from installing permanent potable water irrigation systems for watering **non-playing-field** landscaped areas *and* specify drought resistant plants or grasses in these areas so that irrigation is not needed at all.

Significant amounts of potable water are currently used to irrigate landscaping and playing fields. Although the Northeast region receives an average of several inches of rainfall per month, expanding development increases the demand for potable water. As more and more water is withdrawn, aquifers and rivers can be stressed to the point of creating water shortages and ecological changes to rivers and streams. Summer dry spells cause the most stress to underground and surface waters as water is withdrawn for irrigation and other outdoor activities but is not replaced by rainfall.

The use of potable water for irrigation can be minimized or eliminated by specifying drought resistive plants and grasses, collecting and using rainwater for irrigation, and/or using highly water-efficient irrigation systems. When specifying water conservative plants, determine soil composition and ensure that existing soils will support the plants to be specified. Consider all operating and maintenance costs of any irrigation equipment specified. If irrigation is necessary, make arrangements to irrigate during morning hours to maximize irrigation benefits and minimize evaporation.

The use of well water, ground water, or surface water (ponds, streams) cannot be used as a measure to obtain reductions under this credit.

Documentation for Water Efficiency Elective Credit 1

Submit a letter from a landscape architect certifying that permanent irrigation systems have not been specified for non-playing-field areas AND that only water conservative plants and grasses have been specified for these areas. The letter must clearly state that no irrigation, manual or otherwise, will be needed in these areas after plants are established. The species of water conservative plants and grasses must also be specified.

Water Efficiency Elective Credit 2: Reduce or Eliminate Irrigation for Athletic Fields

1 credits	**WE EC 2A.** Reduce potable water consumption for irrigation of athletic fields with the use of appropriate soils and drought tolerant grasses. Specify that organic content of soils be between 3% and 7% of total soil content and that grasses be a mixture that performs well in the northeastern United States with little or no irrigation. Utilize high-efficiency irrigation technologies, soil moisture meters/rainfall sensors, and/or captured rainwater.

OR

2 credits	**WE EC 2B.** Eliminate potable water consumption for irrigation of playing fields with the use of water conservative/climate tolerant plantings, soil moisture meters/rainfall sensors, and/or captured rainwater.

The best types of soil for playing fields are 3% to 7% organic content and fall into the following U.S. Department of Agriculture soil categories:

Soil Type	Watering Requirements
Loamy sand	1" per week
Sandy loam	1" per week
Loam	1" per week

Use of well water, ground water, or surface water (ponds, streams) is not allowed to obtain reductions under this credit.

Documentation for Water Efficiency Elective Credit 2

Credit WE EC 2A: Submit a narrative from a qualified landscape architect detailing a landscaping plan that meets the above listed criteria.

Credit WE EC 2B: Submit a plan for the athletic playing fields illustrating that no potable water systems will be utilized for irrigation.

If the project includes installing artificial turf, check with the appropriate state environmental department to determine whether there may be additional groundwater recharge requirements for the site. If the turf sheds too much rainwater, it may be considered impermeable and thus the project may be required to add or expand a groundwater recharge system on the site.

Resources

State cooperative extension services, http://www.csrees.usda.gov/Extension/index.html

Water Efficiency Elective Credit 3: Create an Irrigation Commissioning Plan

1 credit	**WE EC 3.** Create an irrigation commissioning plan followed by installation review during construction, performance testing after installation, and documentation for ongoing operations and maintenance.

An irrigation commissioning plan will help to assure that the irrigation system operates properly supplying water efficiently to only the intended areas. The commissioning plan should also specify maintenance strategies to keep the system working efficiently in the future.

Documentation for Water Efficiency Elective Credit 3

Submit an irrigation commissioning plan that has been prepared for the bid specifications, including the following:

1) Identification of who will perform the commissioning tasks
2) Review of irrigation system installation during construction, with record of deficiencies found and corrected
3) Acceptance testing of all components (pipes, connectors, heads, back-flow prevention devices, sensors, timers, etc.

4) Performance testing and documentation of results (as compared to specified performance) at least once during the first year of installation
5) Creation and distribution of site-specific documentation for ongoing operation and maintenance information including recommended irrigation schedule and maintenance schedule

Water Efficiency Elective Credit 4: Install a Rainwater Collection and Water Storage System

2 credits	**WE EC 4.** Install a rainwater collection and storage system to be used for sewage conveyance and/or to irrigate the playing fields when no potable water is to be used.

This credit may be taken in addition to Credit WE EC 2, which mandates reductions in the amount of potable water used for the irrigation of playing fields and/or Credit WE EC 5, which mandates reductions in potable water used for sewage conveyance.

In order to reduce water demand for sewage conveyance and irrigation, some schools opt to use rainwater catchment systems with cisterns or underground storage tanks. These supplementary systems can significantly decrease water demand by drawing on stored water instead of municipal water supplies or drinking water wells.

A rainwater catchment system should be designed with a water storage capacity for sewage conveyance and/or irrigation in typical years under average conditions. In other words, oversizing water storage to meet drought conditions may be costly and could increase maintenance requirements. On the other hand, undersizing storage may simply result in a system that is too small to significantly offset potable water consumption. Rainwater collection and storage systems should be designed to avoid mold growth, bacterial accumulation, and stagnation.

The underground storage tanks and cisterns could at times run dry during drought conditions. Therefore, it is acceptable for tanks and cisterns to connect to wells or municipal water supplies.

Documentation for Water Efficiency Credit 4

Submit a plan for the installation of a rainwater collection system that meets the above requirements. Depending on the credits being applied for, sizing calculations must support the use of rainwater collection for 50% or 100% of playing field irrigation needs and/or 50% of the sewage conveyance needs during an average year.

Resources

CHPS Best Practices Manual, vol. 2, Guideline SP6: Drought Tolerant and Pest-Resistant Plants, Guideline SP10: Water-Efficient Irrigation Systems, Guideline SP12: Reclaimed Water for Irrigation, http://www.chps.net/

LEED Reference Manual, Water Credit 1: Water Efficient Landscaping, http://www.usgbc.org/

Local water utility staff, water efficient landscape consultants, certified irrigation designers

The Irrigation Association, http://www.irrigation.org/

The Irrigation Best Management Practices for Agriculture in New Hampshire is a good reference for assistance in calculating a water budget. The document is available from the NH Department of Environmental Services. NHDES, www.des.state.nh.us

Master Gardeners are also good resources for helping achieve this credit.

Indoor Water Systems

The growing value of potable water underscores the importance of lowering demand. Efficient water consumption naturally reduces the amount of water pumped from the ground or transported from reservoirs to cities and towns. In addition, water efficiency reduces the cost and amount of sewage needing treatment after use. Because water-efficient devices can vary in quality and performance, specify only durable, high performance fixtures.

A maximum of three credits can be earned with the Indoor Systems credits. The following credit promotes well designed, water efficient systems that reduce the amount of potable water used for sewage conveyance. Two additional credits may be obtained by reducing the overall amount of potable water used in the schools.

Water Efficiency Elective Credit 5: Reduce Water Used for Sewage Conveyance

1 credit	**WE EC 5.** Reduce water usage for sewage (blackwater) conveyance by a minimum of 50% through the utilization of water efficient fixtures and/or rainwater catchment systems.

Use water-efficient fixtures and/or site-collected water to reduce the amount of potable water used for sewage conveyance. Only those sources that produce blackwater, such as toilets and urinals, are included in this calculation. Rainwater is suitable for flushing toilets and urinals, which typically produce the largest amounts of wastewater in a school.

To quantify water use reductions, use the following spreadsheets as templates to determine baseline and design water consumption. List each fixture that produces blackwater, the amount of daily uses, number of occupants, and total water use. A water-efficient design for a 1,000-student school is shown in table 2. The example assumes the use of low-flow toilets and waterless urinals, all using non-potable water.

Table 3 – Design Sewage Conveyance Calculation

Fixture Type	Flow-rate	Duration	Occupants	Daily Uses	Water Use (gal)
Toilets (male)	1.6 gal/flush	1 flush	500	1	800
Waterless urinals (male)	0.0 gal/flush	1 flush	500	2	0
Toilets (female)	1.6 gal/flush	1 flush	500	3	2400
Total Daily Volume					3200
				Number of School Days	180
				Design Total Annual Volume	576,000
				Minus Collected Rainwater	(396,000)
				Total Potable Water Used for Sewage Conveyance	180,000

Calculate Daily Water Use per fixture using the following equation:
Daily Water Use = (Flow-rate) (Duration) (Occupants) (Daily Uses)
Sum Daily Water Volumes for each fixture to find Total Daily Volume.
Multiply the Total Daily Volume by the number of school days for Total Annual Volume.

Subtract the amount of reclaimed water used to find Total Potable Water Used for Sewage Conveyance.
For baseline indoor water consumption calculations, use a similar spreadsheet in the Application Template, but change only the type of fixture and its associated design details. For baseline calculations, assume flow rates outlined by the Energy Policy Act of 1992's fixture performance requirements:

Table 4 – EPAct Fixture Performance Requirements

Fixture	EPAct Requirement
Toilets	1.6 gallons/flush
Urinals	1.0 gallons/flush
Showerheads	2.5 gallons/minute
Faucets (non-lavatory)	2.5 gallons/minute
Lavatory faucets	0.5 gallons/minute or 0.25 gallons/cycle – Massachusetts State Plumbing Code*
Replacement aerators	2.5 gallons/minute
Metering faucets	0.25 gallons/cycle

** For lavatory faucets in public buildings, Massachusetts code supersedes EPAct fixture performance requirements.*

Table 5 – Baseline Sewage Conveyance Calculation

Fixture Type	Flow-rate	Duration	Occupants	Daily uses	Water use (gal)
Conventional toilet (male)	1.6 gal/flush	1 flush	500	1	800
Conventional urinal (male)	1.0 gal/flush	1 flush	500	2	1000
Conventional toilet (female)	1.6 gal/flush	1 flush	500	3	2400
				Total Daily Volume	4200
				Number of School Days	180
				Baseline Total Annual Volume	756,000

Comparing the two spreadsheets, the water-efficient fixtures reduced potable water use for sewage conveyance by:
% Savings = 1 – (Design Total Annual Volume / Baseline Total Annual Volume) = 1 – (180,000/756,000) = 0.76 = 76%

Therefore, this design would earn one point because potable water used for sewage conveyance has been reduced by 76% through using reclaimed water in the toilets and urinals. Note that the low-flow fixtures by themselves were not enough to earn this credit.

Documentation for Water Efficiency Credit 5

1) Perform calculations as outlined above using the Application Template.
2) Submit specification section for blackwater fixtures and highlight the gallons per flush.

Resources

LEED Reference Guide, Water Credit 2: Innovative Waste Water Technologies, Water Credit 3: Water Use Reduction, http://www.usgbc.org/

Water Efficiency Elective Credit 6: Reduce Total Interior Water Usage by a Minimum of 30%.

2 credits	**WE EC 6.** Employ strategies that, in aggregate, reduce potable water use by 30% beyond the baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992's fixture performance requirements.

This credit awards reductions in total water use that go beyond the reductions required for Water Efficiency Prerequisite 1. Follow the same procedure as specified in the prerequisite to demonstrate compliance with this credit.

Documentation for Water Efficiency Credit 6

Provide the same documentation as required for Water Efficiency Prerequisite 1.

Resources

LEED Reference Guide, Water Credit 2: Innovative Waste Water Technologies. http://www.usgbc.org/

IX. Materials Selection and Specification

Purpose: To encourage the use of healthy materials and material practices that have a low impact upon the environment.

Summary Tables

Materials Prerequisites

Required	**M P 1.** Specify materials that have been tested and certified for low emissions of volatile organic compounds (VOCs).
Required	**M P 2.** The school shall provide an easily accessible area serving the entire school that is dedicated to the separation, collection, and storage of materials for recycling, including – at a minimum – paper (white ledger and mixed), cardboard, glass, plastics, and metals.
Required	**M P 3.** Recycle, reuse, and/or salvage at least 50% (by weight) of non-hazardous construction and demolition waste, not including land clearing and associated debris.

Materials Elective Credits

1 credit	**M EC 1.** Reuse large portions of existing structures during renovation or redevelopment projects. Maintain at least 50% of existing building structure and shell (exterior skin and framing, excluding window assemblies). Hazardous materials that are remediated as part of the project scope **and** elements requiring replacement due to unsound material condition shall be excluded from the calculation of the percent maintained.
1 credit	**M EC 2.** Maintain 50% of the non-structural interior elements (walls, floor coverings, and ceiling systems).
1-2 credits	**M EC 3 (A, B).** Specify salvaged or refurbished building materials.
1-2 credits	**M EC 4 (A,B).** Achieve a minimum recycled content rate of at least 5% by using a recycled-content calculation that rewards products that exceed 20% recycled-content material.
1 credit	**M EC 5.** Specify rapidly renewable building materials for 0.5% of total building materials.
1 credit	**M EC 6.** Specify that a minimum of 50% of the wood-based materials used for construction are certified in accordance with the Forest Stewardship Council (FSC) or the American Forest and Paper Association's Sustainable Forestry Initiative (SFI) guidelines for wood building components. This includes all wooden framing, flooring, casework, and finishes.
1-2 credits	**M EC 7(A, B).** Specify building materials that are manufactured regionally within a radius of 500 miles.

Materials Selection and Specification Prerequisites

Materials Prerequisite 1: Specify Low Emission Materials

Required	**M P 1.** Specify materials that have been tested and certified for low emissions of volatile organic compounds (VOCs).

The selection of materials for the construction and furnishing of a school can have a major impact on indoor air quality. Many common indoor building and surfacing materials contain a variety of potentially carcinogenic and/or toxic chemicals. These chemicals are released into the air and can cause a variety of health problems, from minor irritation to major health problems. Recent studies have implicated volatile organic compounds (VOCs) as significant risk factors for asthma. Exposure to VOCs emitting from sources such as cigarette smoke, cleaning agents, solvents, furnishings, paint, flooring products, building materials, and personal hygiene products may increase the risk of asthma and other ailments. This is especially important in schools because children are typically more sensitive to indoor air pollutants than adults.

To meet this prerequisite, the following materials must be certified:

- ❑ 50% of adhesives and sealants
- ❑ All acoustic ceiling tiles and acoustic wall panels
- ❑ All carpet systems
- ❑ All interior paint
- ❑ All wall coverings (do not use vinyl wall paper)
- ❑ All solid and composite wood flooring
- ❑ All insulation installed interior to the building vapor barrier
- ❑ All resilient looring

Low VOC products must be certified by one of the programs listed below or be listed by the California CHPS program:

- ❑ Scientific Certification Systems
- ❑ Indoor Advantage – Gold
- ❑ Floor Score
- ❑ GREENGUARD Certification Program – http://www.greenguard.org/
- ❑ Carpet and Rug Institute
- ❑ Green Label Plus

Documentation for Materials Prerequisite 1

Submit a document providing specifications for the interior products covered by the above categories. Include in the document:

1) Product brand name and manufacturer identifying product number.
2) Identification that the product is certified by one of the qualifying programs.

3) If the product is not listed, provide product specifications demonstrating compliance with the standards for the appropriate certifying program.

Resources

GREENGUARD Environmental Institute, http://www.greenguard.org/

Green Seal, http://www.greenseal.org/

EPA, http://yosemite1.epa.gov/oppt/eppstand2.nsf/Pages/Homepage.html/

Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, by the California Department of Health Services, http://www.dhs.ca.gov/ehlb/IAQ/VOCS/LORS/Section01350_7_15_2004_FINAL%20WITH%20ADDENDUM-2004-01.doc

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Materials Prerequisite 2: Storage and Collection of Recyclables

Required	**M P 2.** The school shall provide an easily accessible area serving the entire school that is dedicated to the separation, collection, and storage of materials for recycling, including – at a minimum – paper (white ledger and mixed), cardboard, glass, plastics, and metals.

The recycling of many common materials is promoted throughout Northeast with a variety of recycling programs and services. Typical recyclables include aluminum cans, steel cans, newspaper, white paper, corrugated cardboard, single polymer plastics, and glass bottles. In order to qualify for this credit, school administrators must designate areas in the school where these materials can be handled and sorted.

Early in building occupancy programming, be sure to reserve space for recycling functions and show areas dedicated to the collection of recycled materials on space utilization plans. Consider the question of how recyclable materials will be collected and removed from classrooms and teachers' lounges. When recycling bins are used, they should be able to accommodate a 75% diversion rate (from normal waste basket contents) and be easily accessible to custodial staff and recycling collection workers. Consider bin designs that allow for easy cleaning to avoid health issues.

Documentation for Materials Prerequisite 2

1) Submit plans showing recycling collection area and storage bins and/or dumpsters
2) Submit a description of how recyclable materials will be removed from classrooms, teachers' lounges etc. and how directions for separating recyclable materials will be communicated to teachers, students, and custodians.

Resources

Northeast Recycling Council, http://www.nerc.org/

California Integrated Waste Management Board Recycling Space Allocation Guide, http://www.ciwmb.ca.gov/publications/localasst/31000012.doc

Technical assistance is available from the Northeast Resource Recovery association, www.recyclewithus.org, and the following state contacts:

Connecticut Department of Environmental Protection,
http://www.dep.state.ct.us/wst/recycle/ctrecycles.htm

Maine State Planning Office Waste Management and Recycling Program,
http://www.state.me.us/spo/recycle/

Massachusetts Department of Environmental Protection,
http://www.mass.gov/dep/recycle/recycle.htm

New Hampshire Department of Environmental Services,
http://www.des.state.nh.us/waste_intro.htm

Rhode Island Resource Recovery Corporation, http://www.rirrc.org/

Vermont Agency of Natural Resources,
http://www.anr.state.vt.us/dec/wastediv/R3/recycle.htm

Materials Prerequisite 3: Site Waste Management

Required	**M P 3.** Recycle, reuse, and/or salvage at least 50% (by weight) of non-hazardous construction and demolition waste, not including land clearing and associated debris.

This prerequisite encourages the diversion of construction and demolition waste, produced from construction and renovation projects to beneficial uses. This eases the burdens on landfills and increases the market for these materials. The prerequisite requires that a reasonable percentage (75%) of non-hazardous construction and demolition wastes be diverted.

Waste Management Plans

Successful salvage, recycling, and diversion of construction and demolition materials is usually the result of a well-thought-out waste management plan and on-site training for contractors and subcontractors. Develop and specify a waste management plan that identifies:

1. The diversion percentage goals for C&D wastes
2. Deconstruction, salvage, and recycling/reuse strategies and processes, e.g. scheduling of different stages of deconstruction to best remove recyclable or salvageable materials intact
3. Methods of on-site communication directing the contractors and sub-contractors about what, how, when, and where to recycle
4. Licensed haulers and processors of recyclables
5. Documents needed to show waste diversion – e.g. weight tickets for all wastes removed from the site including recycled and salvaged materials. If items are removed and no weight tickets are generated, be sure to document the materials and date, estimate the weight and volume of the materials, and add them into the overall total for waste and/or salvaged/recycled material removed from the site
6. A method for collecting all recycling and waste data and organizing for an audit of the achieved recycling rates on the project

Compliance calculations for this credit must be based on weight. Many recycling and landfill facilities weigh incoming materials. Shipments that cannot be weighed can be estimated based on their volume and density.

Recycle Rate (%) = Recycled Waste [Tons] / Recycled Waste [Tons] + Garbage [Tons] x 100

Note: DO NOT include materials classified as hazardous wastes in these calculations.

Documentation for Materials Prerequisite 3

1) Submit a copy of the waste management plan developed according to the above criteria.
2) Submit a copy of a contract/s with contractor/s who will execute the plan.

Resources

CHPS Best Practices Manual, vol. 2, Guideline GC2: Construction and Demolition Waste Management, http://www.chps.net/

LEED Reference Guide, Materials Credit 2: Construction Waste Management, http://www.usgbc.org/

Recycling Construction and Demolition Wastes: A Guide for Architects and Contractors, www.architects.org/emplibrary/CD_Recycling_Guide.pdf

Connecticut: Department of Environmental Protection, http://dep.state.ct.us/wst/recycle/candd.htm.

Massachusetts Department of Environmental Protection, Bureau of Waste Prevention, C&D Waste Prevention, www.mass.gov/dep/recycle/cdhome.htm

New Hampshire Department of Environmental Services, Waste Management Division, http://www.des.state.nh.us/waste_intro.htm.

Vermont Agency of Natural Resources, http://www.anr.state.vt.us/dec/wastediv/recycling/CandD.htm.

Materials Selection and Specification Elective Credits

Materials Elective Credit 1: Building Reuse

1 credit	**M EC 1.** Reuse large portions of existing structures during renovation or redevelopment projects. Maintain at least 50% of existing building structure and shell (exterior skin and framing, excluding window assemblies). Hazardous materials that are remediated as part of the project scope **and** elements requiring replacement due to unsound material condition shall be excluded from the calculation of the percent maintained.

Reusing buildings can save significant money and resources, while greatly reducing the amount of construction waste. When materials are re-used, the environmental benefits start with resource savings and extend down through the entire lifecycle of the material: less energy is spent extracting, processing, and shipping the materials to the site. Depending on the amount of the building re-used, school districts can significantly reduce their construction and material costs. However, the building envelope will significantly affect many important high performance areas, such as space programming, energy performance, opportunities for daylighting, and indoor air quality. In addition, care must be taken to ensure that any environmental hazards such as toxins, lead, and asbestos have been identified and their removal addressed. Develop a list of benefits and tradeoffs and make the decision based upon the overall, integrated design tradeoffs.

The percentage of reused structural materials (foundation, slab on grade, beams, floor and roof decks, etc) and shell materials (roof and exterior walls) should be estimated in square feet. Average together the structural and shell reuse percentages. The average will be used to determine the overall reuse percentage for the building.

$$Building\ Reuse(\%) = \frac{1}{2}\left(\frac{ReusedStructuralElements(ft^3)}{TotalStructuralElements(ft^3)} + \frac{ReusedShellElements(ft^2)}{TotalShellElements(ft^2)} \right) \times 100$$

Documentation for Materials Elective Credit 1

1) Submit demolition plans.
2) Submit calculations using the above scoring template to determine amount of reused structural and shell elements.

Resources

LEED Reference Guide, Materials Credit 1: Building Reuse, http://www.usgbc.org/

Materials Elective Credit 2: Reuse Interior Building Elements

1 credit	**M EC 2.** Maintain 50% of the non-structural interior elements (walls, floor coverings, and ceiling systems).

Percentage of reused, non-shell building portions will be calculated as the total area (ft^2) of reused walls, floor covering, and ceiling systems, divided by the existing total area (ft^2) of walls, floor covering, and ceiling systems.

$$InternalBuilding\ Reuse(\%) = \frac{ReusedNonstructuralElements(ft^2)}{TotalNonstructuralElements(ft^2)} \times 100$$

Documentation for Materials Elective Credit 2

1) Submit demolition plans.
2) Submit floor plans showing existing elements.
3) Submit calculations using the above scoring template to determine amount of reused non-structural interior elements.

Resources

LEED Reference Guide, Materials Credit 1: Building Reuse, http://www.usgbc.org/

Materials Elective Credit 3: Resource Reuse

1 credit	**M EC 3A.** Specify salvaged or refurbished materials for 0.5% of building materials.

OR

2 credits	**M EC 3B.** Specify salvaged or refurbished materials for 1% of building materials.

Re-used materials or products are salvaged from a previous use or application and then used in a new use or application with only superficial modification, finishing, or repair. Commonly salvaged building materials include wood flooring/paneling/cabinets, doors and frames, mantels, ironwork and decorative lighting fixtures, brick, masonry, heavy timbers, and on-site concrete used as aggregate. Ensure that the salvaged materials, especially structural elements, comply with all applicable codes.

$$SalvageRate(\%) = \frac{SalvagedMaterialCost\,(\$)}{TotalMaterialCost\,(\$)} \times 100$$

Exclude all labor costs, all mechanical and electrical material costs, and project overhead and fees. If the cost of the salvaged or refurbished material is below market value, use replacement cost to estimate the material value; otherwise use actual cost to the project.

Documentation for Materials Elective Credit 3

1) Submit specifications for salvaged material OR copies of receipts for salvaged material
2) Submit calculations following the above formula.

Resources

CHPS Best Practices Manual, vol. 2, Material Selection and Research Section, http://www.chps.net/

LEED Reference Guide, Materials Credit 3: Resource Reuse, http://www.usgbc.org/

Materials Elective Credit 4: Include Recycled Content In Construction Materials

1 credit	**M EC 4A.** Achieve a minimum recycled content rate of 5% by using a weighted average recycled-content calculation that rewards products that exceed 20% recycled-content material.

OR

2 credits	**<u>M EC 4B.</u>** Achieve a minimum recycled content rate of 10% by using a weighted average recycled-content calculation that rewards products that exceed 20% recycled-content material.

The number and variety of products using recycled-content materials expands every year. Using these materials closes the recycling loop by creating markets for materials collected through recycling programs across the country. It also reduces the use of virgin materials and landfill waste. Recycled-content alternatives exist for all major building materials and surfaces. Recycled content is either a post-consumer (collected from end users) or secondary material. Secondary material (also known as post-industrial or pre-consumer) is collected from manufacturers and industry.

The objective of this credit is to maximize post-consumer recycled content; therefore post-industrial recycled content is discounted 50% for the calculations.

Exception: Structural steel may not be counted toward the recycled content of your building materials. However, the cost of steel may also be removed from the project's total materials costs for the calculations.

The weighted average calculation methodology outlined below rewards materials that contain at least 20% post-consumer material by weighting them more heavily.

1) Sum the Material Cost for all products used in the school to find the Total Project Material Cost. Material cost is the construction cost of a material excluding all labor and equipment costs, mechanical, plumbing, and electrical materials costs, project overhead, and fees.
2) Identify each material that contains at least 20% Post-consumer Recycled-content, and calculate the weighted value of the Post-Consumer Recycled-Content

   Weighted Value = Material Cost x Post-Consumer Recycled Content Percentage

3) Identify each material that contains at least 20% Post-Industrial Recycled-Content and calculate the weighted value of the Post-Industrial Recycled-Content, discounting the total by 50%.

   Weighted Value = (Material Cost x Post-consumer Recycled Content Percentage) x 50%

4) Sum these values to obtain the Total Recycled Content Value for the project.
5) Calculate the total recycled-content as a percentage of total project material cost.

   Recycled Content (%) = (Total Recycled Content Material Cost) / Total Project Material Cost) x 100

   Earn 1 credit if the total Recycled Content = 5%.

   Earn 2 credits if the total Recycled Content = 10%.

Documentation for Materials Elective Credit 4

1) Submit specifications for each recycled material.
2) Submit calculations following the above listed formulas.
3) Submit purchase orders for each listed material.

Resources

CHPS Best Practices Manual, vol. 2, Interior Surfaces and Finishes chapter, http://www.chps.net/

LEED Reference Guide, Materials Credit 4: Recycled Content, http://www.usgbc.org/

EPA's Comprehensive Procurement Guideline (CPG) Program, http://www.epa.gov/cpg

Materials Credit 5: Specify Rapidly Renewable Materials

1 credit	**M EC 5.** Specify rapidly renewable building materials for 0.5% of total building materials.

Rapidly renewable resources are those materials that substantially replenish themselves faster than traditional resources of the same type. Additionally these materials do not result in significant biodiversity loss, increased erosion, or air quality impacts and are sustainably managed. Products in this category include but are not limited to linoleum, bamboo products, wheat grass cabinetry, oriented strand board, and other wood products made from fast-growing poplar and Monterey pine trees.

To earn this credit, determine the percentage of total building materials from rapidly renewable sources.

$$Rapidly\ Re\,newableMaterialPortion(\%) = \frac{Rapidly\ Re\,newableMaterialCost(\$)}{TotalMaterialCost(\$)} \times 100$$

Exclude all labor costs, all mechanical and electrical material costs, and all project overhead and fees from the calculation.

Documentation for Materials Elective Credit 5

1) Submit specifications for each rapidly renewable material.
2) Using the above template, submit calculations.

Resources

CHPS Best Practices Manual, vol. 2, Interior Surfaces and Finishes chapter, http://www.chps.net/

LEED Reference Guide, Materials Credit 6: Rapidly Renewable Materials, http://www.usgbc.org/

Materials Credit 6: Utilize Certified Wood

1 credit	**M EC 6.** Specify that a minimum of 50% of the wood-based materials used for construction are certified in accordance with the Forest Stewardship Council (FSC) or the American Forest and Paper Association's Sustainable Forestry Initiative (SFI) guidelines for wood building components. This includes all wooden framing, flooring, casework, and finishes.

Refer to the FSC or SFI guidelines for wood building components that qualify for compliance to the requirements and incorporate them into the material selection for the project. Wood products that qualify under a State Tree Farm program may be counted toward this credit if the chain of custody is documented.

To earn this credit, determine the percentage of total new wood based products that are FSC/SFI certified. Exclude all labor costs, all mechanical and electrical material costs, and all project overhead and fees.

Documentation for Materials Elective Credit 6

1) Submit specifications for each certified wood material
2) If applicable, submit documentation of tree farm registration and the chain of custody of products from tree farms.
3) Submit calculations using the above template.

Resources

CHPS Best Practices Manual, vol. 2, Material Selection and Research, Guideline IS5: Wood Flooring, Guideline IS11: Casework and Trim, Guideline IS12: Interior Doors, http://www.chps.net/

LEED Reference Guide, Materials Credit 7: Certified Wood, http://www.usgbc.org/

Materials Credit 7 – Utilize Locally Produced Materials

1 credit	**M EC 7A.** Specify a minimum of 20% of building materials that are manufactured regionally within a radius of 500 miles.

OR

2 credits	**M EC 7B.** Specify a minimum of 40% of building materials that are manufactured regionally within a radius of 500 miles.

The use of locally manufactured materials not only aids the local economy, but also reduces the environmental impacts from the transportation of goods.

Calculation: To earn this credit, determine the percentage of products that are locally manufactured. Exclude all labor costs, all mechanical and electrical material costs, and all project overhead and fees.

$$LocalPortion(\%) = 100 \times \frac{Local\ ProductsCost(\$)}{Total\ ProductsCost(\$)}$$

Documentation for Materials Elective Credit 7

1) Submit a table or spreadsheet detailing all local materials and the location of manufacture. The location of manufacture refers to the final assembly of components into the building product that is furnished and installed by tradesmen.

2) Submit a calculation based on the above template.

Resources

Green Building Pages, http://www.greenbuildingpages.com/main_md.html

X. Site Selection and Layout

Purpose: To choose sites that protect students and staff from outdoor pollution and minimally impact the environment. Channel development to centrally located areas with existing infrastructure to protect greenfields, minimize transportation requirements, and preserve habitat and natural resources.

Summary Tables

Site Prerequisites

Required	**<u>S P 1.</u>** Comply with the basic goals of responsible school site selection.
Required	**<u>S P 2.</u>** Site school away from sources of excessive noise, such as airport flight paths, major highways, or frequent industrial or agricultural equipment use.
Required	**<u>S P 3.</u>** Prepare and execute a Stormwater Pollution Prevention Plan addressing erosion and sediment control that complies with the National Pollution Discharge Elimination System Construction General Permit issued by the U.S. Environmental Protection Agency.
Required	**<u>S P 4.</u>** Sustainable Site and Building Layout. Implement three measures from a list of ten best practice site strategies

Site Elective Credits

1 credit	**<u>S EC 1.</u>** Do not temporarily or permanently modify land, which prior to acquisition for the project was public parkland, conservation land, or land acquired for water supply protection unless land of equal or greater value as parkland is accepted in trade or purchased by the public landowner.
1 credit	**<u>S EC 2.</u>** Do not develop buildings on land whose elevation is lower than the elevation of the 100-year floodplain as defined by FEMA and as shown on the FEMA Flood Insurance Rate Map (FIRM) for the site.
1 credit	**<u>S EC 3.</u>** Do not develop school sites that are within 50 ft of any wetland. Site development includes the school facilities, playing fields and parking lots and construction operations that are not related to wetlands improvement. **Exception**: Drainage outfall structures may be located within the 50 ft. buffer zone.
1 credit	**<u>S EC 4 (A, B).</u>** In urban areas, do not build on sites that have not been previously developed, or sites that have been restored to agricultural, forestry, or park use. In rural areas, do not build on sites that currently support agricultural, forestry, or recreational uses.
1 credit	**<u>S EC 5.</u>** Build the school with a reduced footprint, and a Floor Area Ratio (FAR) of at least 1.4
1 credit	**<u>S EC 6.</u>** Provide sidewalks, bike lanes, and bike racks
1 credit	**<u>S EC 7.</u>** Implement an aggressive stormwater management plan.
1 credit	**<u>S EC 8</u>**. Reduce “Heat Island” Effect.
1 Credit	**<u>S EC 9.</u>** Minimize light pollution from outdoor lighting by minimizing the amount of lighting and carefully selecting fixtures.
1 Credit	**<u>S EC 10.</u>** Enhanced Sustainable Site Design. Adopt a minimum of three additional measures from the measures listed in Site Prerequisite 5.

Site Selection and Layout Prerequisites

Site Prerequisite 1: Comply with Basic School Site Selection Goals

Required	**S P 1.** Comply with the basic goals of responsible school site selection.

Note: As with other sections of the Protocol, this section is not meant to repeat or replace any state or federal regulations. It is assumed that all relevant regulations will be followed.

The site on which a proposed school is to be built shall conform to the following requirements:

- ❑ The site selected must meet the educational and health needs of the students and staff and minimize any possible adverse educational, environmental, social, or economical impacts upon the community. Such adverse impacts include, but need not be limited to the following: the need to provide new sewers, roads, transportation facilities, water supply, water connections, and other utilities to the site; existence of soil conditions that will cause site development costs to be greatly increased; curtailment of the approved educational program.
- ❑ The site shall be so located as to serve efficiently and safely the school population it is intended to serve and shall be of sufficient size to accommodate the building and planned future additions, outdoor educational programs, needed parking areas, bus turnarounds, and delivery areas.
- ❑ The site shall be reasonably free from olfactory, auditory, visual, and noxious pollution, or should be capable of being made so prior to commencement of construction.
- ❑ The site shall be located away from hazardous industrial, agricultural, or natural pollution sources.
- ❑ When possible, site shall be located away from major roadways to minimize asthma and other health problems, as well as noise pollution.
- ❑ Site away from nearby facilities that might reasonably be anticipated to emit hazardous air emissions or to handle hazardous or acutely hazardous materials, substances, or waste and determine that they will not adversely affect student, staff, or teacher health.
- ❑ Site the project with a minimum separation of 100 feet from 50-133kV power lines, 150 feet from 220-230kV power lines, 250 feet from 500-550kV power lines, and 1500 feet from railroad tracks, hazardous pipelines, and major highways.
- ❑ Proximity to other facilities such as libraries, museums, parks, natural resources, nature study areas, and business, which would enhance the proposed educational program shall be carefully studied and strongly encouraged.

Protecting student health is the most important issue during site selection. These requirements are intended to eliminate sites containing pollutants known to be hazardous to student and staff health. A variety of factors, from hazardous materials in the soil to airborne pollutants from nearby sources, are included in the site review process.

Documentation for Site Prerequisite 1

Submit a brief narrative explaining how the site meets the requirements of items #1-5.

Resources

EPA, http://www.epa.gov/iaq/radon/

Asthma Regional Council, http://www.asthmaregionalcouncil.org/

American Lung Association, http://www.lungusa.org/

Site Prerequisite 2: Avoid Noise Pollution

Required	**S P 2.** Whenever possible site school away from sources of excessive noise, such as airport flight paths, major highways, or frequent industrial or agricultural equipment use.

This requirement is intended to eliminate sites at which background noise would prevent classroom windows from being open or would restrict outdoor activities.

Documentation for Site Prerequisite 2

Submit a brief narrative describing the site in relation to local sources of excessive noise. When siting near a source of excessive noise is the only option, describe noise abatement actions and procedures.

Site Prerequisite 3: Manage Construction Erosion and Sedimentation Control

Required	S P 3. Prepare and execute a Stormwater Pollution Prevention plan addressing erosion and sediment control that complies with the National Pollution Discharge Elimination System Construction General Permit issued by the U.S. Environmental Protection Agency.

Exception: If land disturbance is less than 100,000 square feet for the entire project as a whole, then the project is exempt from this prerequisite. However, all projects involving the protection of wetlands must meet this requirement.

The plan shall meet the following objectives:

- ❑ Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- ❑ Prevent sedimentation of storm sewer or receiving streams and/or air pollution with dust and particulate matter

Documentation for Site Prerequisite 3

Submit a copy of the project Stormwater Pollution Prevention plan.

Resources

CHPS Best Practices Manual, vol. 2, Guideline GC4: Site Protection During Construction, http://www.chps.net/

LEED Reference Guide, Site Prerequisite 1: Erosion and Sedimentation Control, http://www.usgbc.org/

EPA On-line Best Practices information, http://www.tetratech-test.com/bmpmanual/htmfolder/menu.htm

Connecticut Department of Environmental Protection, Stormwater Program, http://dep.state.ct.us/wtr/stormwater/stormwtrindex.htm

Maine Department of Environmental Protection, Stormwater Program, http://www.state.me.us/dep/blwq/docstand/stormwater/index.htm

Massachusetts Department of Environmental Protection, Stormwater Program, http://www.mass.gov/dep/brp/stormwtr/stormhom.htm

Massachusetts Wetlands and Waterways Management Information, http://www.mass.gov/dep/water/index.htm

New Hampshire Department of Environmental Services, Stormwater Program, http://www.des.state.nh.us/StormWater/

Rhode Island Department of Environmental Management, Stormwater Program, http://www.dem.ri.gov/programs/benviron/water/permits/ripdes/stwater/index.htm

Vermont Agency of Natural Resources, Stormwater Section, http://www.anr.state.vt.us/dec/waterq/stormwater.htm

U.S. Environmental Protection Agency Stormwater Management for Construction Activities, http://cfpub.epa.gov/npdes/stormwater/swppp.cfm

U.S. Environmental Protection Agency Construction General Permits, http://cfpub1.epa.gov/npdes/stormwater/cgp.cfm

U.S. Environmental Protection Agency Construction General Permit Information, http://www.epa.gov/NE/npdes/stormwater/construction_act_ma.html

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Site Prerequisite 4: Utilize Best Practices for Site and Building Layout

Required	**S P 4.** Sustainable site and building layout. Implement three measures from a list of ten best practice site strategies 1. Orient the building(s) to take advantage of maximum natural daylighting and plot shadow patterns from surrounding buildings and place buildings to optimize solar gain (for urban-infill sites). 2. Consider prevailing winds when determining the site and building layout. For example, consider how the shape of the building itself can create wind-sheltered spaces and consider prevailing winds when designing parking lots and driveways to help blow exhaust fumes away from the school. 3. Take advantage of existing land formations and vegetation to provide shelter from extreme weather or to deflect unwanted noise.

4. Plant or protect existing deciduous trees to block summer sun and allow winter solar gain. Plant or protect existing coniferous trees to block winter wind.

5. Minimize importation of non-native soils and exportation of native soils. Optimize Cut & Fill (ideally 1:1) during clearing and excavation.

6. Create physical connections to existing bike paths, natural features, or adjacent buildings and neighborhoods.

7. Design parking lots and driveways to limit student proximity to bus emissions. Design bus loading and unloading areas such that buses need not be lined up head to tail. Do not design bus loading and unloading areas such that bus exhaust is in proximity to any of the school's air intake vents.

8. Site the building to maximize opportunities for on-site renewable energy generation. For example, preserve or ensure availability of space for wood chip storage facilities for biomass heating, wind turbines (if wind resources are adequate), or other renewable energy sources.

9. Encourage the use of public transportation by locating the school within 1/4 mile of a commuter rail, light rail, or subway station, or within 1/8 mile of one or more bus lines.

10. Implement a comprehensive car/van pooling program for staff members, providing premium parking for participating vehicles.

Performing a thorough site analysis at the pre-design phase is critical to understanding all the opportunities and complexities of a building site. A good site analysis allows the designer to make informed design decisions to take full advantage of solar orientation, prevailing wind direction, topography, and tree species and locations. Adjacent streets and traffic patterns should be considered, functional synergies with surrounding buildings created, and special environmental elements featured.

Item #1 highlights the importance of building orientation. Energy efficiency and environmental impacts are affected by decisions made early in the planning process. For example, when the building is oriented along the east-west axis, the designer can take advantage of natural daylighting, which reduces the need for electrical lighting and resultant energy consumption.

Note: Urban infill projects do not usually have the opportunity to orient the building to the sun, due to tight site constraints. However, project designers are encouraged to think about maximum solar exposure within the limits of the surrounding buildings.

Item #2 encourages designers to consider prevailing winds to help move vehicle exhaust away from the school, minimizing exposure to students and staff.

For items #3 and #4, earth berms, forests, and other natural features can help shape the layout of the school building during early design. Likewise, manmade structures, such as storage structures for bio-mass fuel, can be sited carefully to provide protection to the site. Plantings of deciduous trees provide shade to the school during warmer months and access to sunlight at the end of autumn when the trees' leaves have fallen.

Importation or exportation of soil can be costly in terms of both dollars and environmental impact. Item #5 encourages the conservation of the environment by minimizing excavation and importation of non-native soils. By optimizing cut and fill (ideally 1:1) during clearing and excavation, use of native soils is maximized, reducing the adverse impacts on the site.

In item #6, “creating physical connections” means considering features on adjacent properties and designing the site layout such that it promotes their use.

For item #7, the figures (1 & 2) below demonstrate a traditional dismissal practice experienced at many schools (figure 1) and one that avoids traditional head to tail lining up of buses (figure 2). In the approach in figure 2, bus exhaust is not near the intake for other buses or the school ventilation system. When considering site placement of bus parking, also consider prevailing winter winds so that exhaust is not blown into the school air intakes. (Source of text and graphics below is the Asthma Regional Council, http://www.asthmaregionalcouncil.org/about/BusToolkit.htm)

FIGURE 1. TRADITIONAL BUS QUEUING STRATEGIES

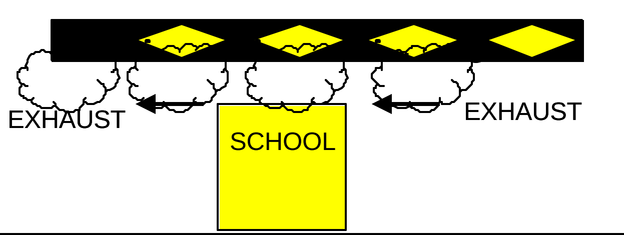
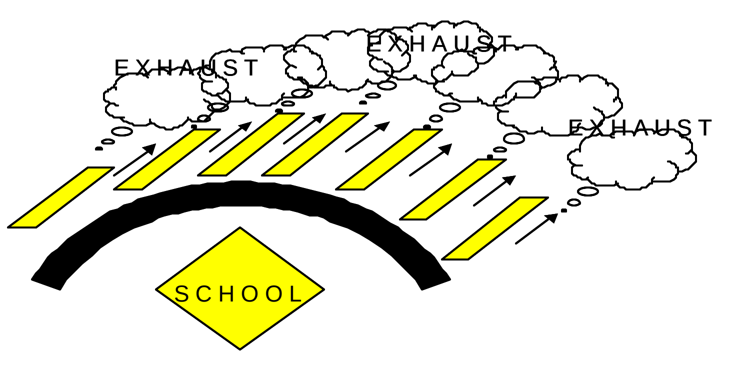


FIGURE 2. EFFECTIVE QUEUING TO REDUCE CHILDREN'S EXPOSURE TO EMISSIONS



Plymouth South School District, MA

Item #8 encourages early consideration of opportunities for on-site renewable energy generation. Biomass heating, for example, can be and effective option for many school projects, but the building and site layout must consider the need for wood chip storage. Wind electricity generation may also make sense for many schools, but wind resources should be investigated early and designers should investigate the best location for turbines on the school site.

Documentation for Site Prerequisite 4

For all strategies attempted, submit site analysis sketches outlining all of the site's features before the building is placed and submit the following for individual strategies for at least three of the items listed below. Site layouts and design narratives may be combined where appropriate.

1) Site layout and design narrative showing how the project responds to natural daylighting.
2) Site layout and design narrative showing how the project responds to prevailing winds.
3) Site layout and landscape design narrative showing how the existing topography and tree coverage respond to weather or deflects unwanted noise.
4) Site layout and landscape design narrative showing how the intended or existing plantings increase shade in the summer and allow solar gain in the winter.
5) Submit a cut and fill analysis report that shows a maximum of a 5% deviation to a 1:1 ratio. If avoidable, please do not submit the entire report, only the sections that identify the report and support the intent of a 1:1 ratio of excavation and infill with native soils.
6) Site layout and design narrative showing how the project responds to natural features and/or adjacent buildings.
7) Site plan showing bus loading and unloading area. Also show on this drawing, or submit a separate drawing, that shows that the building's air intake vents are not located near the loading/unloading zone.
8) Site layout and design narrative showing how the project responds to opportunities for on-site renewable energy generation.
9) Supply area map locating transportation lines with distance to school noted.
10) Supply a copy of an implementation plan for a car/van pooling program. The program must include incentives (financial or other) for staff participation.

Resources

CHPS Best Practices Manual, vol. 2, Guideline GC4, http://www.chps.net/

LEED Reference Guide, Site Prerequisites, http://www.usgbc.org/

Site Selection and Layout Elective Credits

Site Elective Credit 1: Preserve Greenspace and Parklands

1 credit	S EC 1. Do not temporarily or permanently modify land, which prior to acquisition for the project was public parkland, conservation land, or land acquired for water supply protection, unless land of equal or greater value as parkland is accepted in trade or purchased by the public landowner.

Maintain open spaces. If at all possible, do not build on land, which prior to acquisition for the project was public parkland, conservation land, land acquired for water supply protection or land restored to agricultural or forestry use.

Documentation for Site Elective Credit 1

Submit assessor's map or similar documentation of existing site conditions.

Site Elective Credit 2: Avoid Floodplains

1 credit	**S EC 2.** Do not develop buildings on land whose elevation is lower than the elevation of the 100-year floodplain as defined by FEMA and as shown on the FEMA Flood Insurance Rate Map (FIRM) for the site.

Do not construct permanent buildings within the 100-year floodplain.

100-Year Floodplains: Both federal and state agencies have worked together over the last several decades to prevent construction of buildings in 100-year floodplains to achieve two important results: 1) a significant decrease in building damage and liability and 2) a restoration of functional floodplains to absorb flood waters and minimize impacts to downstream communities.

The "above the floodplain" requirement applies to the building footprint only, not the site as a whole. Balanced cut and fill could be used to help applicants achieve this elevation, as long as it does not impact the 100-year floodplain itself.

Maps of 100-year floodplain elevations are available on the web at http://www.fema.gov/fhm or http://www.msc.fema.gov, or call 877-336-2627 to talk to a map specialist.

Documentation for Site Elective Credit 2

Submit FIRM Map, highlighting the 100-year floodplain area OR provide map from FEMA website with 100-year floodplain highlighted. Show that the building footprint will not be in the 100-year flood level.

Resources

FEMA Floodplain Maps,
http://www.fema.gov/cgi-shl/selector.pl?URL=%2Fhazard%2Fmap%2Findex.shtm&Submit=Go+#flood

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Site Elective Credit 3: Protect Wetlands

1 credit	**S EC 3.** Do not develop school sites that are within 50 ft of any wetland. Site development includes the school facilities, playing fields and parking lots and construction operations that are not related to wetlands improvement. **Exception**: Drainage outfall structures may be located within the 50 ft. buffer zone.

Do not build on sites that are within 50 ft. of a wetland as defined by the state in which the schools is located. Site development includes the school facilities, playing fields and parking lots, and construction operations that are not related to wetlands improvement. Drainage outfall structures may be located within the 50 ft. buffer zone.

Each state in the region may have somewhat different definitions of wetlands, but wetlands generally include swamps, marshes, bogs, and similar areas that support vegetation associated with wet areas. Any wetlands areas on or near the site must be delineated by a qualified professional and indicated on the project site plan.

Documentation for Site Elective Credit 3

Submit project site plan and a statement addressing any issues involving wetlands on or near the site.

Resources

State's Department of Environmental Protection

Local and Regional Conservation Commissions

Site Elective Credit 4: Protect Greenfields

1 credit	**S EC 4A.** In urban areas, do not build on sites that have not been previously developed, or sites that have been restored to agricultural, forestry, or park use.

OR

1 credit	**S EC 4B.** In rural areas, do not build on sites that currently support agricultural, forestry, or recreational uses.

During the site selection process, use previously developed sites instead of greenfields. Urban redevelopment reduces environmental impacts by utilizing established infrastructure and preserving the open space of undeveloped lands. For rural areas, previously developed sites are likely unavailable, but protecting agricultural and recreational land is a priority.

Documentation for Site Elective Credit 4

Submit a narrative describing compliance with this credit.

Resources

State's Department of Environmental Protection

Site Elective Credit 5: Reduce Building Footprint

1 credit	**S EC 5.** Reduced footprint. Increase the Floor Area Ratio (FAR) of the school to be at least 1.4 to reduce the development footprint and preserve open space. The FAR is the quotient of the building's total square footage divided by the square footage of its footprint.

Building multi-story schools reduces the amount of land used in construction. Said another way, achieving a FAR of 1.4 requires at least 40% of a school's total square footage to be above the first floor.

Documentation for Site Elective Credit 5

Submit a calculation of the Floor Area Ratio (FAR) by dividing the school facility's footprint by the facility's entire square footage including all stories.

Site Elective Credit 6: Provide Enhanced Bicycle and Pedestrian Access

1 credit	S EC 6. Provide sidewalks or walkways that extend at least to the end of the school zone and bike lanes that connect to residential areas at least ¼ mile from the school entrance at the public way and into the school zone itself. Provide suitable means for securing bicycles for 5% or more of building occupants (students and staff). For elementary schools, count only students in the 4th grade and above as building occupants.

The purpose of this credit is to provide safe access to the school by students and staff who choose to walk or ride their bicycles to school. To protect pedestrians, sidewalks or walkways must extend to the end of the school zone. To protect and encourage cyclists, bike lanes must extend at least a quarter mile from the school entrance into surrounding neighborhoods to ensure cyclist safety.

Documentation for Site Elective Credit 6

Submit a site plan highlighting:

- ❑ Sidewalks extending to the end of the school zones
- ❑ Bike paths within the school zone and extending ¼ mile into surrounding neighborhoods
- ❑ Location of bike racks and detailing the number of bikes the racks can accommodate

Resources

CHPS Best Practices Manual, vol. 2, Guideline SP3: Safe and Energy-Efficient Transportation, http://www.chps.net/

LEED Reference Guide, Site Credit 4, http://www.usgbc.org/

Site Credit 7: Reduce Post-Construction Stormwater Runoff

1 Credit	S EC 7. Implement a stormwater management plan that results in a 25% decrease in the peak runoff rate for the 2-year, 24-hour storm from existing to developed conditions AND design a stormwater system that results in a 25% decrease in runoff volume for the 100-year, 24-hour storm from existing to developed conditions.

Stormwater runoff is precipitation that flows over surfaces on the site and enters either the sewage system or receiving waters. Stormwater carries sediment and pollutants from the site into the sewage system and/or local bodies of water. In addition, the cumulative runoff throughout the local area requires significant investments in municipal infrastructure to handle peak runoff loads.

Reducing the amount of runoff is the most effective way to minimize its negative impacts. Many strategies exist to limit stormwater runoff, including the following:

- ❑ Significantly reduce impervious surfaces, maximize on-site stormwater infiltration, and retain pervious and vegetated areas.
- ❑ Capture rainwater from impervious areas of the building for groundwater recharge or for reuse.
- ❑ Use green/vegetated roofs.

Documentation for Site Elective Credit 7

Submit a Stormwater Management plan demonstrating compliance with the above criteria.

Resources

See Site Prerequisite 3

Site Elective Credit 8: Landscape to Reduce Heat Island Effect

1 Credit	S EC 8. Provide shade (within five years) on at least 30% of non-roof, impervious surfaces on the site, including parking lots, walkways, plazas, etc. ***OR*** use light-colored / high-albedo materials (reflectance of at least 0.3) for 30% of the site's non-roof, impervious surfaces ***OR*** use a combination of shading and high-albedo materials for 30% of the site's non-roof surfaces.

Although the "heat island effect" is largely an urban phenomenon, dark surfaces, such as pavement, cladding, and roofing absorb heat and radiate it back to surrounding areas. In cities, where there are many dark, heat absorbing surfaces, infrared radiation can boost temperatures by 10ºF or more. The heat island effect increases the need for air conditioning (and therefore electricity consumption) and is detrimental to site plantings, local wildlife, and maintaining comfortable temperatures.

Employ design strategies, materials, and landscaping designs that reduce heat absorption of exterior materials. Provide shade using native or climate-tolerant trees and large shrubs, vegetated trellises, or other exterior structures supporting vegetation. Substitute vegetated surfaces for hard surfaces. Explore the elimination of blacktop with the use of new coatings with integral colorants to achieve light colored surfaces.

Documentation for Site Elective Credit 8

1. Submit a site plan or landscaping plan designating trees that contribute to shade and/or light colored non-roof impervious surfaces.

2. Submit shading calculations:

3. Identify all non-roof impervious surfaces on the project site and sum the total area.

4. Identify all trees that contribute shade to non-roof impervious surfaces. Highlight these trees on the plan you submit.

5. Calculate the shade coverage provided by these trees after five years of growth on the non-roof impervious surfaces on June 21 at solar noon to determine the maximum shading effect.

6. Determine the total area of shade provided for non-roof impervious surfaces. Divide by total – result must be 30%.

7. Submit calculations for the use of light-colored/high-albedo materials:

8. Identify all non-roof impervious surfaces on the project site and sum the total area.

9. Calculate the total area of non-roof impervious surfaces designed with light-colored/high-albedo materials. Divide by total – result must be 30%.

10. If light-colored / high-albedo materials are used to achieve this credit, provide specifications.

Note: Applicants may achieve 30% coverage by adding together areas of shading and areas of light-colored/high-albedo materials to total 30%.

Resources

CHPS Best Practices Manual, vol. 2, Guideline GC4, http://www.chps.net/

LEED Reference Guide, Site Prerequisites, http://www.usgbc.org/

Site Elective Credit 9: Minimize Light Pollution from Outdoor Lighting

1 Credit	S EC 9. Minimize light pollution from outdoor lighting by minimizing the amount of lighting and carefully selecting fixtures.

Light pollution obscures the night sky and is intrusive to neighboring properties. Glare from outdoor lighting can make night vision difficult, especially for drivers on or near the property. The over-lighting of the site also wastes significant amounts of energy and contributes to maintenance budgets with the expensive cost of replacing high wattage lamps mounted at heights requiring bucket trucks or lifts.

In order to qualify for this credit, the following criteria should be followed:

1) Light only those areas where exterior lighting is clearly required for safety and comfort. Do not install light fixtures whose main purpose is to light building façades or landscape features.
2) Provide light levels that do not exceed those recommended by the Illuminating Engineering Society of North America (IESNA), Standards: RP-33 *Lighting for Exterior Environments*; RP-8 *American National Standard Practice for Roadway Lighting*; RP-20 Lighting for Parking Facilities; and RP-6 *Recommended Practice for Sports and Recreational Area Lighting*.
3) Specify IESNA Cutoff or IESNA Full Cutoff for all exterior site and building mounted lighting fixtures. Specify IESNA Full Cutoff for all exterior site and building mounted lighting fixtures.
4) For fixtures situated close to the school property line and where the property line abuts residential properties, parks, or natural wildlife areas, provide shielding to prevent view of the lamp from any point 5 feet or higher above the ground along the property line.
5) All exterior site and building mounted lighting fixtures that are only needed when the school is open for nighttime use (i.e. not needed all night and/or every night for security reasons) shall be controlled with easily accessed manual switch controls and a timeclock.
6) Do not install mercury vapor, incandescent, incandescent halogen, or standard (probe-start) metal halide lamps. Fluorescent, high-pressure sodium, and pulse-start metal halide lamps are the current high efficiency options for outdoor lighting.
7) Signs, monuments, and flags. Signs should be lighted from the top down. Fixtures for school signs, monuments, and flags are limited to 50 watts per fixture, and must incorporate shielding devices such as hoods, louvers, and source shields. The fixtures are exempt from the cutoff requirements of #3.
8) Sports field lighting design must follow IESNA RP-6 *Recommended Practice for Sports and Recreational Area Lighting*. Fixtures must incorporate extensive shielding to minimize and redirect stray light. Controls must be provided that encourage the shutting off of the lights when the sports field is not in use. Fixtures specifically for lighting sports fields are exempt from the full cutoff requirements listed in #3 and shielding requirements in #4.

Documentation for Site Elective Credit 9

Submit the following:

1) An exterior lighting fixture schedule with manufacturers and model numbers, and manufacturer's spec sheets with a clear description of the specified lamping, wattage, IESNA cutoff classification (where applicable), and shielding accessories for each fixture.
2) A photometric site plan produced by computer modeling with the following information:
    - ❑ Horizontal illuminances at ground level on a minimum 10-ft. by 10-ft. grid with the property line clearly and boldly marked on photometric plan and abutting residential properties, parks, or natural wildlife areas noted.
    - ❑ Maximum illuminances for each area (walkways, parking lots, driveways, building entries, etc.)

- ❑ The location and mounting height of all site and building mounted exterior fixtures clearly indicated, with fixture type designations relating to the lighting fixture schedule.

- ❑ Light loss factors used for each fixture type.

A photometric plan produced by computer modeling for any sports field lighting.

Provide information on lighting controls and circuiting to verify compliance with control requirements.

Resources

Illuminating Engineering Society of North America, www.iesna.org

CHPS Best Practices Manual, vol. 2, EL11: Outdoor Lighting, http://www.chps.net/

National Lighting Product Information Program, *Lighting Answers*, vol. 7, issue 2, "Light Pollution," www.lrc.rpi.edu/programs/NLPIP

LEED Reference Guide, Site Credit 8: Light Pollution Reduction, www.usgbc.org

The International Dark Sky Association, http://www.darksky.org

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Site Elective Credit 10: Enhanced Sustainable Site Design

1 Credit	S EC 10. Adopt a minimum of three additional measures from the measures listed in Site Prerequisite 5.

Site Prerequisite 5 mandates that three of listed measures be implemented. Implement at least three additional measures to obtain this credit.

Site Elective Credit 10 Documentation:

See Site Prerequisite 5.

XI. Section Eleven: Innovation

Purpose: To recognize design teams and project owners for adopting innovative high performance features, greatly exceeding existing credits, or adopting significant policies that truly represent best practices in sustainability and/or environmental health and safety.

1-3 credits	I EC 1. The Innovation credits offer an opportunity to earn credits for practices that are not listed in the Protocol, but which enhance the performance attributes of the completed project. These credits can also be garnered to reward efforts that significantly exceed the existing credit parameters.

The prerequisites and elective credits listed in this document represent performance standards that are recognized by the education and building design communities as practices that are relatively common and are reasonably obtainable. However, no document can comprehensively cover all aspects of high performance design. New ideas and new technologies need to be encouraged and supported.

These credits for innovative practices are offered for communities that incorporate new creative ideas into their school projects, and/or incorporate performance that goes beyond what is promoted in the Protocol.

Innovation credits could include, but are not limited to:

Develop a comprehensive and innovative plan for using the sustainable aspects of the school as teaching tools.

Include cutting edge technologies for energy efficiency or environmental benefit.

Design and install a combined heat and power plant.

Obtain LEED accreditation that includes credits that are not available in this Protocol.

Documentation for Innovation Credits

To achieve innovation credits:

1) Define the technology or action and its purpose
2) Describe the proposed criteria for compliance including any applicable standards
3) Identify and submit documentation that verifies compliance with the proposed credit
4) Submit a narrative describing how the credit reflects sustainable or environmental health and safety practices.

To achieve enhanced performance credits:

1) Identify the Protocol criteria that applies
2) Describe the proposed technology, action, or policy and how performance is significantly enhanced in comparison with Protocol requirements.

For examples of Innovation credits, see the LEED NC 2.1 reference guide.

Evaluation

The administrators of the Northeast High Performance Schools Protocol or designated state officials will convene a team of experts to evaluate all proposals for innovation credits.

High Performance Schools Protocol Scorecard

Policy and Operations – Possible Points: 8

*R / C	Section	Description
R	PO P 1	High performance design advisory committee
R	PO P 2	Joint use of facilities
R	PO P 3	Indoor environmental management plan
R	PO P 4	Maintenance plan
R	PO P 5	ENERGY STAR equipment
R	PO P 6	No idling measures
R	PO P 7	Elimination of CFC and HCFC
1C	PO EC 1	Computerized maintenance plan
1C	PO EC 2.1	Renewable energy certificates (RECs) 10%
2C	PO EC 2.2	Renewable energy certificates (RECs) 25%
1C	PO EC 2.3	Renewable energy certificates (RECs) local 200 miles
1C	PO EC 3.1	Alternative-fuel demonstration project
2C	PO EC 3.2	Alternative-fuel buses
2C	PO EC 3.3	Alternative-fueled maintenance vehicles and equipment

***R = Required; C= Credit**

Indoor Environmental Quality – Possible Points: 11

*R / C	Section	Description
R	IEQ P 1	Access to views 70%
R	IEQ P 2	Classroom daylighting
R	IEQ P 3	Low-glare lighting systems
R	IEQ P 4	ASHRAE 62.1-2004
R	IEQ P 5	Walk-off system
R	IEQ P 6	Prevent water accumulation
R	IEQ P 7	Prevent spray on buildings
R	IEQ P 8	Prevent mold problems during construction
R	IEQ P 9	Use IAQ best practices
R	IEQ P 10	Replace all HVAC filters
R	IEQ P 11	Filter requirements – MERV filter
R	IEQ P 12	Only electric ignitions for gas fired
R	IEQ P 13	Properly ;locate outside air intakes
R	IEQ P 14	ASTM standard for ductwork
R	IEQ P 15	Prohibit fossil fuel inside building
R	IEQ P 16	Acoustical standards – ANSI 12.60-2002
R	IEQ P 17	ASHRAE 55-2004
R	IEQ P 18	Integrated pest management
1C	IEQ EC 1	Install dedicated exhaust for pollutant source control
1C	IEQ EC 2	Installed ducted air returns
1C	IEQ EC 3	Install premium HVAC filtration
1C	IEQ EC 4	Provide operable windows
1C	IEQ EC 5	Install high intensity florescent lighting in gym
1C	IEQ EC 6	Construction management – provide ventilation
1C	IEQ EC 7	Construction management – protect ductwork
2C	IEQ EC 8	Construction management – provide HEPA vacuuming

2C	IEQ EC 9	Construction management – provide building flushout

***R = Required; C= Credit**

Energy Efficiency – Possible Points: 10

*R / C	Section	Description
R	EE P 1 (A, B, or C)	Energy efficiency standards
R	EE P 2	Air barrier
R	EE P 3	HVAC design and meet ASHRAE 55-2004
R	EE P 4	Commission all energy using systems
R	EE P 5	Training and documentation
R	EE P 6	Energy efficiency incentives
1C	EE EC 1A	Demonstrate superior energy performance – 30% reduction
2C	EE EC 1B	Demonstrate superior energy performance – 40% reduction
4C	EE EC 1C	Demonstrate superior energy performance – 50% reduction
1C	EE EC 2	Incorporate daylighting and control at least 40%
1C	EE EC 3	Perform enhanced building commissioning
1C	EE EC 4	Minimize air conditioning
1C	EE EC 5	Install variable air volume (VAV) system
1C	EE EC 6	Install energy management system
1C	EE EC 7	Install submetering systems

***R = Required; C= Credit**

Renewable Energy – Possible Points: 18

C	Section	Description
1C	RE EC 1A	Renewable solar thermal energy 1%
2C	RE EC 1B	Renewable solar thermal energy 2%
1C	RE EC 2A	Renewable solar photovoltaic energy – 1%
2C	RE EC 2B	Renewable solar photovoltaic energy – 3%
3C	RE EC 2C	Renewable solar photovoltaic energy – 5%
4C	RE EC 2D	Renewable solar photovoltaic energy – 10%
1C	RE EC 3A	Install renewable wind energy system – 1%
2C	RE EC 3B	Install renewable wind energy system – 3%
3C	RE EC 3C	Install renewable wind energy system – 5%
4C	RE EC 3D	Install renewable wind energy system – 10%
2C	RE EC 4A	Install renewable biomass energy system – 10%
3C	RE EC 4B	Install renewable biomass energy system – 20%
1-5C	RE EC 5	Install unlisted renewable energy system

Water Efficiency – Possible Points: 10

*R / C	Section	Description
R	WE P 1	Reduce total interior water usage by 20%
1C	WE EC 1	Eliminate irrigation for non-playing-field landscaping
1C	WE EC 2A	Reduce or eliminate irrigation for athletic fields
2C	WE EC 2B	Eliminate potable water consumption for athletic fields
1C	WE EC 3	Create an irrigation commissioning plan
2C	WE EC 4	Install a rainwater collection and water storage system

1C	WE EC 5	Reduce water used for sewage conveyance by at least 50%
2C	WE EC 6B	Reduce total interior water usage by at least 30%

***R = Required; C= Credit**

Materials Prerequisites – Possible Points: 10

*R / C	Section	Description
R	M P 1	Specify low emission materials
R	MP 2	Storage and collection of recyclables
R	MP 3	Site waste management
1C	M EC 1	Building reuse
1C	M EC 2	Reuse interior building elements
1C	M EC 3A	Resources reuse .5%
2C	M EC 3B	Resources reuse 1%
1C	M EC 4A	Include recycled content in construction materials 5%
2C	M EC 4B	Include recycled content in construction materials 10%
1C	M EC 5	Specify rapidly renewable materials
1C	M EC 6	Utilize certified wood
1C	M EC 7A	Utilize locally produced materials 20%
2C	M EC 7B	Utilize locally produced materials 40%

***R = Required; C= Credit**

Site Prerequisites – Possible Points: 10

*R / C	Section	Description
R	S P 1	Comply with basic school site selection
R	S P 2	Avoid air and water pollution sources
R	S P 3	Manage construction erosion and sedimentations control
R	S P 4	Utilize best practice for site and building layout
1C	S EC 1	Preserve greenspace and parklands
1C	S EC 2	Avoid floodplains
1C	S EC 3	Protect wetlands
1C	S EC 4A	Protect greenfields – urban
1C	S EC 4B	Protect greenfields – rural
1C	S EC 5	Reduce building footprint
IC	S EC 6	Provide enhanced bicycle and pedestrian access
1C	S EC 7	Reduce post-construction stormwater runoff
1C	S EC 8	Landscape to reduce heat island effect
1C	S EC 9	Minimize light pollution from outdoor lighting
1C	S EC 10	Enhanced sustainable site design

***R = Required; C= Credit**

Innovation – Possible Points: 3

C	Section	Description
1-3C	I EC 1	Innovation

Glossary

ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers.

ASTM – American Society for Testing and Materials.

B-20 –The term for a blend of 20% renewable bio-derived diesel fuel with 80% petroleum-based diesel fuel.

biodiesel – A domestic, renewable fuel for diesel engines derived from natural oils like soybean oil, which meets the specifications of American Society for Testing and Materials D 6751. Biodiesel is not the same thing as raw vegetable oil. It is produced by a chemical process that removes the glycerin from the oil.

biogas – Gas, rich in methane, which is produced by the fermentation of animal dung, human sewage, or crop residues in an air-tight container. It is used as a fuel to heat stoves and lamps, run small machines, and generate electricity. The residues of biogas production can be used as a low-grade organic fertilizer.

bio-oil – A liquid created from biomass (see below) found in forestry and agricultural residues. The biomass is thermochemically converted to bio-oil by using processes called direct liquefaction or fast pyrolysis. The high water and oxygen content of bio-oils reduces their heating value to less than half the value of petroleum. However, bio-oils are low in viscosity and have been successfully burned in boilers, kilns, turbines, and diesel engines.

biomass –Any biological material that can be used as fuel. Biomass fuel is burned or converted in systems that produce heat, electricity, or both. In this document, biomass-fired systems refer to systems that are fueled by clean wood chips from forestry or saw mill operations.

brownfields –Industrial or commercial property that is abandoned or underused, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

CSI – Construction Specifications Institute.

CHPS – Collaborative for High Performance Schools.

COMcheck –Software developed by the U.S. DOE to help commercial projects demonstrate compliance with all commercial energy code requirements for envelope, lighting, and mechanical systems. For more information, see http://www.energycodes.gov/comcheck/.

commissioning – A systematic process of ensuring that all building systems perform interactively according to the contract documents, the design intent, and the schools operational needs. Commissioning involves three phases: pre-design, construction, and warranty.

commissioning plan – A plan that includes a list of all equipment to be commissioned, delineation of roles for each of the primary commissioning participants, and details on the scope, timeline, and deliverables throughout the commissioning process.

cool roof – A roof that reflects most of the sun's energy instead of absorbing it into the interior spaces below.

daylighting –The practice of placing windows and reflective surfaces so that the natural light of day provides effective internal illumination. Optimize the daylighting design to minimize glare and eliminate direct-beam light in the classroom and use daylighting controls designed to dim or turn off electric lights when sufficient daylight is available.

Design-Build – A construction-project delivery process in which a single entity assumes the obligation of furnishing the design, supervision, and construction services required to complete a project.

DOE-2 – Software that was developed by the U.S. DOE to predict the fuel consumption (both electric and fossil fuel) of a building based on its design. Later iterations include DOE 2.2, a more advanced form of the original software.

DOE-2.1E – An updated version of DOE-2 software.

e-QUEST – (**QU**ick **E**nergy **S**imulation **T**ool) – Sophisticated software that allows for detailed energy analysis of a designed building. It also allows users to build 2-D and 3-D displays of the building geometry.

ENERGY STAR - A program that maintains a database of compliant manufactures and products. Partial list of products include computers, monitors, copy machines, water coolers, printers, scanners, refrigerators, and washing machines.

gray water system – Water that has been used in showers, sinks, and laundry machines that may be reused for other purposes, especially landscape irrigation. Toilet water is not used in this system.

greenfields- Parcels of land not previously developed beyond that of agriculture or forestry use. The opposite of brownfield.

heat island – An effect caused when exterior surfaces absorb the sun's energy and heat the air near the ground. On a school site, rising temperatures make the school's air conditioning work harder, increasing energy cost.

HEPA filters – High Efficiency Particulate Air filters

integrated pest management (IPM) – A sustainable approach to managing pests that minimizes economic, health, and environmental risks.

integrated design – The consideration and design of all building systems and components. It brings together the various disciplines involved in designing a building and reviews their recommendations as a whole. It also recognizes that each discipline's recommendation has an impact on other aspects of the building project.

life cycle costing – A means of calculating and comparing different designs, equipment, and products to identity the best investment.

recycled content – Materials that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer) or after consumer use (post consumer).

OSHA – Occupational Safety and Health Administration.

operations and maintenance manual – Provides detailed operations and maintenance information for all equipment and products used in the school.

operations and maintenance training – Provides a short introduction on operations and mainetenance of equipment and products for all school staff and then features hands-on workshops for facility personnel.

potable water – Water of sufficient quality to serve as drinking water.

PowerDOE – Software that allows users to detail the predicted energy consumption of a building. Like e-QUEST, it is very graphical in its presentation of both the building description and the display of results. It includes 2-D and 3-D displays of the building geometry.

rain water collection system – A system that supplies water year round by harvesting both potable and non-portable water.

rapidly renewable materials – Materials that substantially replenish themselves faster than traditional extraction demand (e.g. planted and harvested in less than a 10-year cycle), do not result in significant biodiversity loss or increased erosion, positively impact air quality, and can be sustainably managed. Products in this category include, but are not limited to, bamboo products, wheat grass cabinetry, oriented strand board, and other wood products made from fast-growing pine trees.

responsibly produced – Materials that are extracted, harvested, or manufactured in an environmentally friendly manner (includes certified wood products).

salvaged or reused – Materials that are refurbished and used for a similar purpose rather than processed or remanufactured for different use.

thermal comfort – A condition of mind that expresses satisfaction with the surrounding environment. It is determined by taking into account environmental factors (such as humidity, A/C, heat) and personal factors (what an occupant is wearing).

VisualDOE – Energy modeling software that is based on DOE-2 and allows users to evaluate energy and demand impacts of design alternatives.

VOC – Volatile Organic Compounds

wetlands –Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support vegetation adapted for life in saturated soil. Wetlands generally include swamps, marshes, bogs, and other similar areas.

Appendix B: Committee's Evaulation Criteria

Criteria	Globe	NEEP	LEED
Will use of the standard result in achieving the goal of creating a good HPS building?	C	A	B
How adaptable is the code for Vermont?	C	A	D
How costly is the work to comply with the code (soft and hard costs)?	B	B	C
What is the cost of getting certified as compliant?	B	B	C
Ability to define cost/benefit.	B	B	B
Ability to improve standard.	C	C	A
How user friendly, implementable, is the code? Is training available? Access to info?	D	C	B
TOTALS	16	21	18

Point System

A = 4 points
B = 3 points
C = 2 points
D = 1 point

Appendix C: Vermont Addenda to Protocol

1/3/07

Vermont Addenda to Northeast HPS Protocol,
High Performance Schools Exchange / Northeast Energy Efficiency Partnerships

Policy and Operations
PO EC.1 CMMS must include an operations manual and training module.

Indoor Environmental Quality
IEQ EC 7 is changed from an elective credit to a prerequisite. Add: Prior to occupancy, ductwork must be inspected and certified as clean, or must be professionally cleaned.
IEQ EC 8 is changed from an elective credit to a prerequisite.

Energy Efficiency
EE P1 (A, B, or C) is wholly replaced by:
Design a school or a portion of an existing school building to perform 10% or more above the most-recently adopted Vermont energy code.
(Currently the 2005 Vermont Guidelines for Energy Efficient Commercial Construction)
Throughout the protocol, wherever ASHRAE 2004 and the most-recently adopted Vermont energy code differ, the stricter will govern.

EE P2 Documentation may include blower door test and thermal imaging test results.

EE P5 Training must be completed prior to substantial completion and building turnover. Training is to be recorded for future maintenance staff review.

EE EC1 Reference Vermont code as per EE P1 above.

A 13.5% reduction in total net energy use compared to 2005 Vt Guideline For Energy Efficient Commercial Construction.
B 17%
C 20.5%

Renewable Energy
Add RE P1 Review feasibility of onsite renewable energy systems using Vt Department of Education approved life cycle cost analysis methodology.

RE EC4A 2 credits for using a biomass system to meet 70% of the school's total heat and hot water load, or 70% of the heating load.
RE EC 4B 3 credits for using a biomass system to meet 85% of the total heat and hot water load.

Materials
M EC7 An additional credit for 10% building materials manufactured in Vermont.

Site
S EC2 Replace 100 year flood plain with 500 year flood plain.

Cathy Hilgendorf on behalf of the School Construction Standards Committee

Appendix D: "Why Build a High Performance School Building?"

Harris Materials in support of HP construction from Efficiency Vermont and Vermont Energy Investment Corp.

1. **Why Build a High Performance School Building?**
    a. Reduce negative impacts of buildings on occupants and the environment
    b. Purpose: to enhance a building's overall performance while improving…
        i. Occupant Comfort
        ii. Indoor Environmental Quality
        iii. Energy, Water and Materials Efficiency
        iv. The Bottom Line
    c. Some specific technologies and approaches
        i. Alternative Stormwater Treatment
        ii. Solar Building Orientation
        iii. Daylighting
        iv. Natural Ventilation
        v. Building Shell Improvements
        vi. Water-Conserving Fixtures
        vii. Lighting and Mechanical Controls
        viii. Durable Building Materials
        ix. Recycled and Recyclable Building Materials
        x. Renewable Energy Systems
        xi. PV systems, wind turbines
        xii. Indoor air quality strategies
        xiii. low toxicity materials
2. **Overview of benefits and costs**
        i. What is "Cost," Anyway? First Cost? Life Cycle Cost? First Costs for new construction green buildings will vary significantly, depending on the specific project goals and requirements.
        ii. Studies show that the incremental costs vary more by the architectural program, not by the level of "green-ness"
        iii. Estimates for additional first cost are 0-3%
        iv. Data shows Benefit/Cost ratio averages 8:1 for "Green" features
        v. Some "Green" features come at no cost, such as proper building orientation on the site, daylighting strategies, some materials choices
        vi. For existing buildings, sometimes there are initial costs to put new systems in place, others are "no-" or "low-cost" (e.g., scheduling changes)
        vii. Vermont taxpayer pays either way, either through bonds or through levies. Best decision for Vermont taxpayers is to use lowest life cycle cost, or highest benefit to cost ratio as determination
3. **Non-energy benefits:**
        i. Reduction in mold and mildew risks; averted health and building maintenance expenses
        ii. Productivity – enhanced performance and test scores, reduced absenteeism, improved staff and faculty retention
        iii. Durability – averted maintenance
        iv. Reduces foreign energy dependency, increases national security
        v. Reduces building "embodied energy" through averted material use and waste reduction
        vi. Increases occupant well-being, mental health
        vii. Supports local economy

Appendix E: Design Costs for High Performance Schools

December 2006

[The following was submitted by Al Russell, a Vermont architect and current member of the Board of Directors of the Vermont Chapter of the American Institute of Architects (AIA VT). Al is AIA VT's delegate to the school construction standards committee and was also Chief Architect for Dore & Whittier Architects for the last 10 years.]

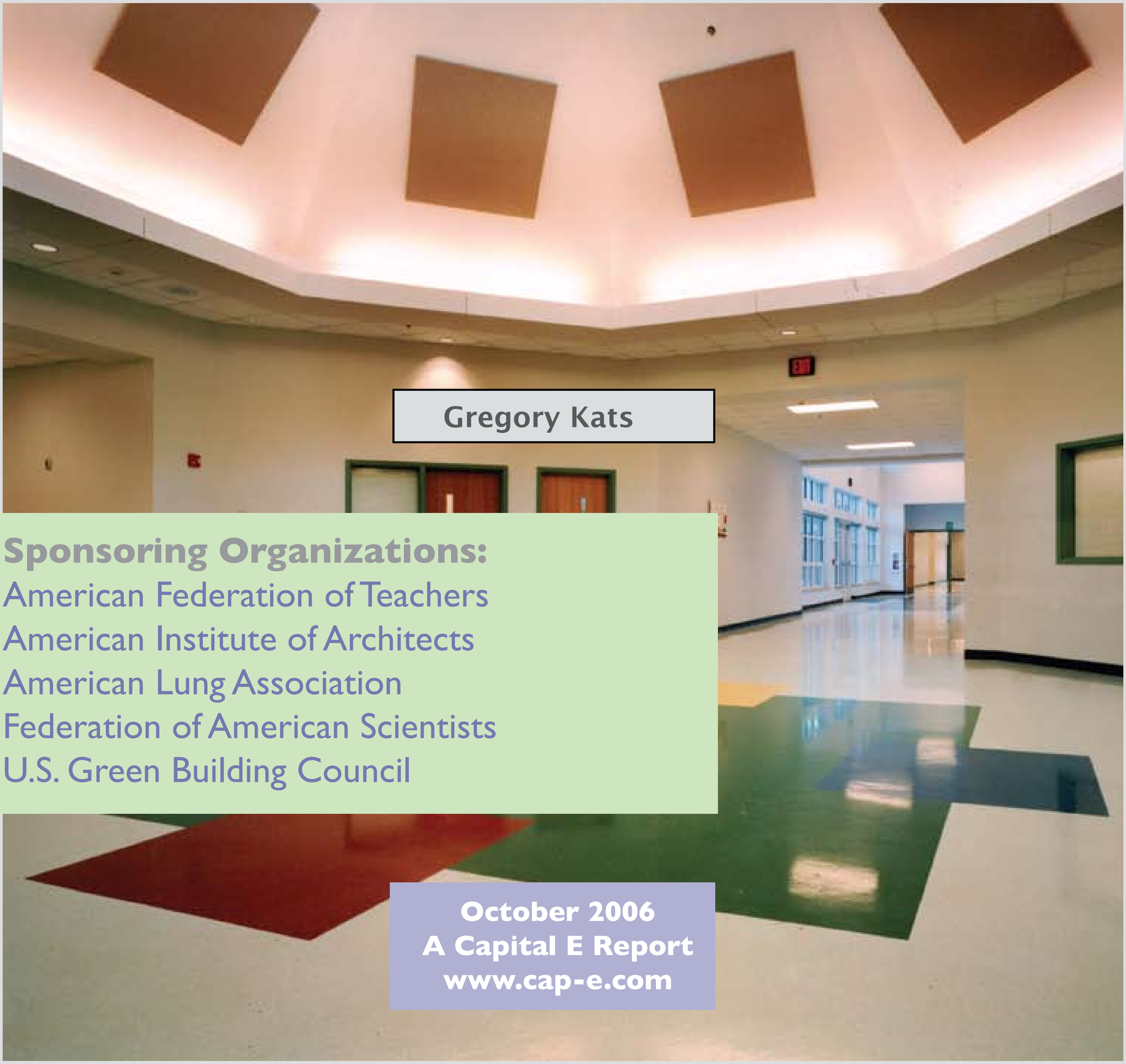
One of the most pressing questions for the school construction standards committee related to design costs: "What are the design costs for High Performance Schools?" As it turns out, this is not an easy question to answer without looking at a specific project. David Epstein, a partner with Truex Cullins and Partners in Burlington and a recent President of AIA Vermont, echoed this concern. Considering the NEEP Protocol for High Performance Schools, there are a number of criteria that are already part of the norm for Vermont projects and Vermont architects, and there are others that are beyond the norm for a public school project in Vermont.

Architects' design costs are related to the time they spend "on the board", attending meetings, conducting studies, preparing reports, and to the fees they must pay to consulting engineers and to other specialists who provide contracted services. Additional meetings, studies, reports, and special consultants usually translate into more time and incrementally higher design costs and fees. Accordingly, the NEEP criteria that are beyond the norm should be expected to result in incrementally higher design fees. At the same time, it should be noted that design practices evolve with technological and social changes and with laws and regulations. 'New' practices and procedures tend to be viewed as 'add-ons' that include a learning cost or other unknown costs. The learning costs may go down as these services are practiced over time and become the norm. For example, CAD (computer aided drafting) services were once seen as an additional cost that was passed on to a client; but today, CAD is the norm, and most firms do not bill extra for CAD time.

Vermont's history with high performance school construction is relatively limited when compared to some other states, and available information on the related design costs is also limited.

Massachusetts is one state that has recently taken steps to encourage high performance school buildings. A few years ago, the Massachusetts Technology Collaborative (MTC) provided grant money for school districts that chose to pursue high performance school design and construction. Dedham Middle School was one of the projects awarded a grant by the MTC. For that school project, the incremental design costs for high performance added approximately ½ of one percent to the total project cost. Analysis indicated that the additional design costs were insignificant when compared to the projected savings in energy costs alone.

Greening America's Schools
Costs and Benefits



Gregory Kats

Sponsoring Organizations:
American Federation of Teachers
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American Lung Association
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U.S. Green Building Council

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www.cap-e.com

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About the Author

Greg Kats is Managing Principal of Capital E, a national clean energy technology and green building firm. He serves as Senior Advisor to Cherokee Investment Partners (www.cherokeefund.com), the country's largest private brownfield developer (with over $5 billion in projected green developments). He is the Principal Advisor in developing $1 billion of green affordable housing, involving Enterprise Community Partners, JPMorgan, Chase, Citibank, NRDC, Fannie Mae, American Institute of Architects, and others (www.greencommunitiesonline.org). He serves as Senior Advisor to the Cheyne Carbon Fund, the leading investor in the voluntary carbon offset market. (Cheyne Capital Management is a $30 billion European hedge fund.)

Mr. Kats served as the Director of Financing for Energy Efficiency and Renewable Energy at the U.S. Department of Energy (1996-2001). With a billion dollar budget, it is the country's largest clean technology development and deployment program, including over $400 million annually in high performance building technology development and deployment. He co-founded and from 1995 to 2001 chaired the International Performance Measurement & Verification Protocol (www.ipmvp.org) that has served as a technical basis for $8 billion in building upgrades, and been translated into 10 languages. Mr. Kats serves as Chair of the Energy and Atmosphere Technical Advisory Group for LEED and serves on the LEED Steering Committee. Mr. Kats recently led a national technical review (for the US EPA) on the performance of Energy Star commercial and public buildings, and is a principal author of *Green Office Buildings: a Practical Guide to Development,* (Urban Land Institute, 2005).

Mr. Kats earned an MBA from Stanford University and, concurrently, an MPA from Princeton University on a Woodrow Wilson Fellowship, and is a Certified Energy Manager and a LEED Accredited Professional. He is a founder of New Resource Bank (www.newresourcebank.com), the country's first green bank, and the American Council of Renewable Energy (www.acore.org), and serves on a half dozen private and public boards. Mr. Kats regularly testifies, serves as keynote speaker at national conferences, and speaks to organizations such as the American Bar Association, the National Academy of Sciences, and the US Conference of Mayors.

Contributing Researcher:
Jon Braman, Capital E

This document is based on and draws from the 2005 report "National Review of Green Schools: Costs, Benefits and Implications for Massachusetts," a report for the Massachusetts Technology Collaborative. Principal Author Greg Kats, contributing author Jeff Perlman, contributing researcher Sachin Jamadagni. (Available at www.cap-e.com.)

This analysis also draws extensively on the 2003 Capital E report "The Costs and Financial Benefits of Green Buildings," a report to California's Sustainable Building Task Force, developed for 40 state agencies.[1] The report was the first to develop a rigorous analysis of the costs and benefits of green buildings, and found that the average cost premium for green buildings was 2%.

Front cover photo:
Third Creek Elementary School
Photography by Spark Productions

Back cover photo (from left to right):
Clearview High School
Photography by Jim Schafer

Mabel Rush Elementary
Photography by Michael Mathers

Third Creek Elementary
Photography by Spark Productions

Layout Design:
Robert Loftur-Thun
Global Environment & Technology Foundation

Reviews of *Greening America's Schools: Costs and Benefits*

"This carefully documented study conclusively demonstrates the financial, environmental, and other benefits of using green technologies in schools. In fact, failure to invest in green technologies is not financially responsible for school systems; the study uses conservative accounting practices to show that investments in green technologies significantly reduce the life-cycle cost of operating school buildings. And the public benefits of green schools are even larger than those that work directly to the financial advantage of schools. These include reductions in water pollution, improved environmental quality, and increased productivity of learning in an improved school environment."

- Henry Kelly, President, Federation of American Scientists

"USGBC is proud to be a sponsor of this important national analysis of the costs and benefits of greening our nation's schools. The report's conclusions provide confirmation of USGBC's position that by building green we all profit. For our nation's students this is particularly true. Children's health is disproportionately affected by indoor pollutants, while light and air quality affects their capacity to learn and succeed. This report shows that we owe it to our children - and ourselves - to make all our schools green."

- S. Richard Fedrizzi, CEO and Founding Chair, U.S. Green Building Council

"High performance, cost effective schools begin with good design. As this study details, nowhere is good design more important than for our schools. Enhanced learning environments that are also environmentally responsible continue to be an ongoing focus of AIA awards programs and government advocacy. But, as the study makes clear, all schools must also be green. Members of The American Institute of Architects believe good design makes a difference. This study underscores the enormous costs of poor design, and the critical impact that good design and operation has on the quality of our children's education. It deserves widespread consideration if we are to properly prepare students to address the environmental challenges of our new century."

- Kate Schwennsen, President, The American Institute of Architects

"This report makes the business case for greening America's schools, and it makes a compelling case indeed. But there is also a public health case to be made. Better indoor air quality, lower levels of chemical emissions, generous provision of natural daylighting, better humidity control--these and other features of green schools offer not only environmental and fiscal benefits, but health benefits as well. These health benefits, in turn, manifest in lower student and staff absenteeism, lower staff turnover, lower health care costs, and improved school and job performance. For the more than 50 million students and the more than 5 million teachers and staff who spend their days in schools, these benefits are substantial and precious. Health professionals, educators, parents, and policymakers should carefully consider the conclusions of this report, and do their part to support environmentally friendly, healthy, and sustainable schools."

- Howard Frumkin, M.D., Dr.P.H., Director, National Center for Environmental Health and Agency for Toxic Substances and Disease Registry, U.S. Centers for Disease Control and Prevention. Senior Editor, *Safe and Healthy School Environments* (Oxford University Press, 2006).

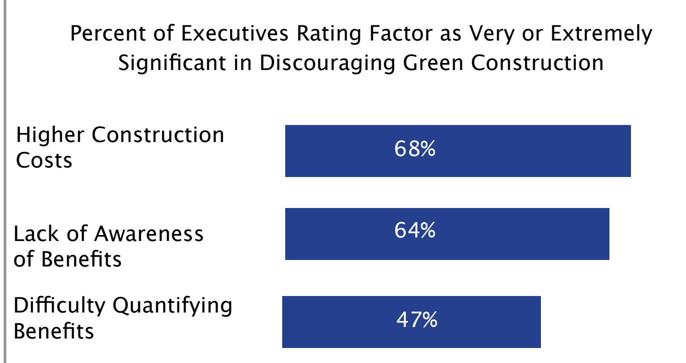
"This carefully documented study conclusively demonstrates the financial, environmental, and other benefits of using green technologies."

Executive Summary

Greening school design provides an extraordinarily cost-effective way to enhance student learning.

Some 55 million students spend their days in schools that are too often unhealthy and that restrict their ability to learn. A recent and rapidly growing trend is to design schools with the specific intent of providing healthy, comfortable and productive learning environments. These green, high performance schools generally cost more to build, which has been considered a major obstacle at a time of limited school budgets and an expanding student population. A 2005 survey by Turner Construction Company of 665 senior executives found that executives are discouraged from undertaking green construction because of concerns about cost, and a lack of awareness and available information on the financial benefits of green buildings.[2]

Figure A: Factors Discouraging the Construction of Green Buildings



Source: Turner Construction Company 2005 Survey of Green Buildings

This report is intended to answer this fundamental question: how much more do green schools cost, and is greening schools cost effective?

Conventional schools are typically designed just to meet building codes - that are often incomplete. Design of schools to meet minimum code performance tends to minimize initial capital costs but delivers schools that are not designed specifically to provide comfortable, productive, and healthy work environments for students and faculty. Few states regulate indoor air quality in schools or provide for minimum ventilation standards. Not surprisingly, a large number of studies have found that schools across the country are unhealthy - increasing illness and absenteeism and bringing down test scores.

This report documents the financial costs and benefits of green schools compared to conventional schools. This national review of 30 green schools demonstrates that green schools cost less than 2% more than conventional schools - or about $3 per square foot ($3/ft^2) - but provide financial benefits that are 20 times as large. Greening school design provides an extraordinarily cost-effective way to enhance student learning, reduce health and operational costs and, ultimately, increase school quality and competitiveness.

The financial savings are about $70 per ft^2, 20 times as high as the cost of going green. (Table A) Only a portion of these savings accrue directly to the school. Lower energy and water costs, improved teacher retention, and lowered health costs save green schools directly about $12/ft^2, about four times the additional cost of going green. For an average conventional school, building green would save enough money to pay for an additional full-time teacher. Financial savings to the broader community are significantly larger, and include reduced cost of public infrastructure, lower air and water pollution, and a better educated and compensated workforce.

Green schools provide a range of additional benefits that are not quantified in this report, including reduced teacher sick days, reduced operations and maintenance costs, reduced insured and uninsured risks, improved power quality and reliability, increased state competitiveness, reduced social inequity, and educational enrichment. There is insufficient data to quantify these additional benefits, but they are substantial and, if calculated, would substantially increase the recognized financial benefits of greening schools.

Table A: Financial Benefits of Green Schools ($/ft^2)

Energy	$9
Emissions	$1
Water and Wastewater	$1
Increased Earnings	$49
Asthma Reduction	$3
Cold and Flu Reduction	$5
Teacher Retention	$4
Employment Impact	$2
TOTAL	$74
COST OF GREENING	($3)
NET FINANCIAL BENEFITS	$71

Building healthy high performance school buildings is now far more fiscally prudent and lower risk than building conventional, inefficient and unhealthy school buildings.

Methodology and Assumptions

Net Present Value

Conventional schools usually have lower design and construction costs and higher operational costs, whereas green schools usually have higher design and construction costs and lower operational costs. To evaluate the current value of a future stream of financial benefits and costs, we use net present value (NPV) analysis, with 2006 as our base year. NPV represents the present value of an investment's discounted future financial benefits minus any initial investment. A positive number indicates a good investment.

Term

This report assumes a 20 year term for benefits in new buildings. A lower, 15 year term for energy efficiency savings in retrofitted existing buildings would be appropriate. A longer term is assumed for a new building because green design affects more permanent features – such as orientation, wall construction, and amount of insulation – which tend to last for the life of building, typically at least 50 years.

Inflation

This analysis assumes an inflation rate of 2% per year, in line with most conventional inflation projections. Unless otherwise indicated, this report makes a conventional assumption that most costs as well as benefits rise at the rate of inflation. The things that are not assumed to rise at the rate of inflation are energy, emissions value, water, waste water and health costs - which are assumed to rise faster than inflation. The rate increases for these are discussed in the relevant sections.

Discount Rate

To arrive at present value and net present value estimates, projected future costs and benefits must be discounted to provide a fair value in today's dollars. Present value calculations are made on the basis of a relatively conservative 7% discount rate (i.e., 5% real interest rate plus an assumed 2% inflation).[3] This is higher than the rate at which states, the federal government, and many corporations borrow money.[4]

Definition of Green Schools

All green school designs are to a substantial extent based on the US Green Building Council's Leadership in Energy and Environmental Design (LEED), which is the national consensus green building standard. An application of LEED for schools was developed for California schools, and is called Collaborative for High Performance Schools (CHPS).[5] This standard was then adapted for Massachusetts schools (MA CHPS),[6] and in 2003, Washington State released its own Washington Sustainable School (WSS) Protocol for High Performance Facilities,[7] also based on a variant of CHPS and LEED. The green schools we analyzed were based on either LEED, MA CHPS, or WSS.

Green schools use an average of 33% less energy than conventionally designed schools.

The Cost of Building Green Schools

Average national school construction cost is $150/ft^2.[8]

The "green premium" is the initial extra cost to build a green building compared to a conventional building. Typically this cost premium is a result of more expensive (and sustainably-sourced) materials, more efficient mechanical systems, and better design, modeling and integration, and other high performance features. Many school architects use a state or school district's pre-determined budget as their metric for appropriate school cost. Some green schools are built on the same budget as conventional schools.

The report data are drawn from 30 green schools built in 10 states during the period 2001 to 2006. The data on costs as well as savings compared to a conventional design were generally supplied by the schools' architects. Some of the costs analyzed in the report are based on actual building performance, while some new school costs are estimates based on architectural modeling and engineering estimates. We generally relied on the costs reported by architects based on their actual and modeled green and conventional versions of the same building. For a breakout of all schools analyzed, see Table B.

Four of the green schools (in Georgia, Massachusetts and Oregon) cost no more than conventional design, while several schools cost substantially more. Six schools cost at least 3% more than conventional design while one – the Punahou School in Hawaii – costs 6.3% more. Typically green schools cost 1% to 2% more, with an average cost premium of 1.7%, or about $3/ft^2.

Increased cost of green design is typically partially offset by savings elsewhere, for example in reduced cost of HVAC systems or in reduced code compliance costs. Similarly, increased water retention through the use of a green roof or greywater system can avoid the capital cost of a water retention system normally required to comply with water codes. The model green school developed by the architectural firm OWP/P for the Chicago market includes a green roof that allows the building to avoid a water retention system, providing savings sufficient to reduce the school cost premium to 1%.[10] A recent evaluation of the impact of LEED adoption, developed for the Portland Energy Office, found that regional life cycle savings from adopting 15 individual green building technologies was over 8 times as large as the direct first cost of these measures.[11]

Achieving full cost savings requires early integrated design.

Benefits of High Performance Schools

Energy Cost Savings in Green Schools

Green schools use an average of 33% less energy than conventionally designed schools (See Table B). Typical energy performance enhancements include more efficient lighting, greater use of daylighting and sensors, more efficient heating and cooling systems and better insulated walls and roofs.

Reduced energy consumption in green schools has two distinct financial benefits: (1) direct reduction in school energy costs, and (2) indirect secondary impact from reduced

Some green schools are built on the same budget as conventional schools.

Table B: School Buildings Analyzed in This Report[9]

Name	State	Year Completed	2005 MA-CHPS	LEED Score	LEED Level or Equivalent	Cost premium	Energy Savings	Water Savings
Ash Creek Intermediate School	OR	2002			CERTIFIED	0.00%	30%	20%
Ashland High School*	MA	2005	19			1.91%	29%	
Berkshire Hills*	MA	2004	27			3.99%	34%	0%
Blackstone Valley Tech*	MA	2005	27			0.91%	32%	12%
Capuano	MA	2003		26	CERTIFIED	3.60%	41%	
Canby Middle School	OR	2006		40	GOLD	0.00%	47%	30%
Clackamas	OR	2002		33	SILVER	0.30%	38%	20%
Clearview Elementary	PA	2002	49	42	GOLD	1.30%	59%	39%
Crocker Farm School	MA	2001	37			1.07%	32%	62%
C-TEC	OH	2006	35	38	SILVER	0.53%	23%	45%
The Dalles Middle School	OR	2002			SILVER	0.50%	50%	20%
Danvers*	MA	2005	25			3.79%	23%	7%
Dedham*	MA	2006	32			2.89%	29%	78%
Lincoln Heights Elementary School	WA	2006			SILVER		30%	20%
Melrose Middle School	MA	2007	36			1.36%	20%	20%
Model Green School	IL	2004		34	SILVER	2.02%	29%	35%
Newton South High School	MA	2006		32	CERTIFIED	0.99%	30%	20%
Prairie Crossing Charter School	IL	2004		34	SILVER	3.00%	48%	16%
Punahou School	HI	2004		43	GOLD	6.27%	43%	50%
Third Creek Elementary	NC	2002		39	GOLD	1.52%	26%	63%
Twin Valley Elementary	PA	2004	41	35	SILVER	1.50%	49%	42%
Summerfield Elementary School	NJ	2006	42	44	GOLD	0.78%	32%	35%
Washington Middle School	WA	2006		40	GOLD	3.03%	25%	40%
Whitman-Hanson*	MA	2005	35			1.50%	35%	38%
Williamstown Elementary School	MA	2002	37			0.00%	31%	
Willow School Phase 1	NJ	2003		39	GOLD		25%	34%
Woburn High School*	MA	2006	32			3.07%	30%	50%
Woodword Academy Classroom	GA	2002		34	SILVER	0.00%	31%	23%
Woodword Academy Dining	GA	2003		27	CERTIFIED	0.10%	23%	25%
Wrightsville Elementary School	PA	2003		38	SILVER	0.40%	30%	23%
AVERAGE						**1.65%**	**33.4%**	**32.1%**

overall market demand and resulting lower energy prices market-wide. Direct savings are in the form of lower bills to the school. Indirect savings result from the impact that reduced demand has in lowering the market price of energy. This indirect impact shows up in minute changes in price across entire markets. For an individual school, this price impact is not measurable, but state-wide or nationally, the price impact of reduced energy consumption in schools could be substantial.

Average school energy use in 2005/2006 was $1.15/ft^2, of which electricity was 63% and natural gas 34%. For the 30 green schools reviewed in this report, the average energy reduction compared with conventional design is 33%, indicating an average savings of $0.38/ft^2 per year in green schools.[12] Average electricity prices are $0.09 kWh in 2006 and rose an average 6% per year over the last three years.[13] The average gas price rose 14% annually over the same period. Future prices are of course unknowable, but finite energy resources combined with rapid projected international demand growth suggests rising prices. This report projects recent rapid growth in average energy prices to slow to 5% per year, or

Clearview High School
John Boecker, Architect with L. Robert Kimball & Assoc.
Photo: Jim Schafer Location Photography

3% above inflation, over the next 20 years.

Over a 20 year period, and assuming 7% discount of future benefits of lower energy prices, the result is a present value of $6/ft^2 for energy savings in green schools. In green building upgrades of existing schools, the present value benefit of reduced energy use over a 15 year period at a 7% discount rate is $5/ft^2. Note that the costs and benefits numbers in this report have all been rounded to the nearest whole dollar amount. Uncertainties about the data, including future price escalation, make greater precision misleading.

Market-wide energy cost savings represent an important additional benefit often not included in energy efficiency financial analyses. The financial benefit of lowered energy prices is substantial and provides an additional reason for public entities such as states or cities to promote or require energy efficiency programs.

The price impact from efficiency-driven reductions in demand can be significant. A 2005 report from Lawrence Berkeley National Laboratory found that a 1% reduction in national natural gas demand can lead to a long-term average wellhead price reductions of 0.8% to 2%.[14] A 2004 Platts Research & Consulting review of nine separate studies determines that a 1% drop in gas demand could drive a 0.75% to 2.5% reduction in long-term wellhead prices. [15] In other words, these studies indicate direct reduction in consumption (and savings in energy costs from increased efficiency) could drive a reduction in long-term prices equal to 100% to 200% of the direct energy savings. A 2004 Massachusetts state report found that the indirect savings from lower overall energy prices due to lower energy demand from use of energy efficiency and renewables amounted to 90% of the direct savings.[16] To be conservative, we assume that the indirect price impact is 50% over 20 years from a broad shift to green, energy efficient school design. Thus, the impact of indirect energy cost reduction for new and retrofitted schools has a present value of $3/ft^2 over 20 years.

The total direct and indirect energy cost savings from a new green school compared with a conventional school is $9/ft^2. Total direct and indirect energy cost savings from a green as compared to a conventional upgrade of an existing school would be $7/ft^2. Note that these numbers have all been rounded to the nearest whole dollar amount, as noted above.

Emissions Reduction Benefits of Green Schools

Residential, commercial and industrial buildings use about 45% of the nation's energy, including about 75% of the nation's electricity. Air pollution, from burning fossil fuels to heat buildings (natural gas and oil) and to generate electricity for these buildings (by burning coal, natural gas and oil) imposes enormous health, environmental, and property damage costs. Demonstrated health costs nationally include tens of thousands of additional deaths per year and tens of millions of respiratory incidents and ailments.[17]

Reduced electricity and gas use in buildings means lower emissions of pollutants (due to avoided burning of fossil fuels) that are damaging to human health, to the environment, and to property. As noted above, green schools on average use one third less energy than conventional schools.[18]

Market-wide energy cost savings represent an important benefit often not included in energy efficiency financial analyses.

As a rough estimate, a green school could lead to the following annual emission reductions per school:

The building sector is responsible for over 40% of US CO_2 emissions – more than any entire economy in the world except China.

- 1,200 pounds of nitrogen oxides (NOx) – a principal component of smog.
- 1,300 pounds of sulfur dioxide (SO_2) – a principal cause of acid rain.
- 585,000 pounds of carbon dioxide (CO_2) – the principal greenhouse gas and the principal product of combustion.
- 150 pounds of coarse particulate matter (PM10) – a principal cause of respiratory illness and an important contributor to smog.

Over 20 years the present value of emissions reductions per square foot is $0.53/ft^2 from a green school.[19]

Mabel Rush High School
Heinz Rudolf, Boora Architects
Photo: Michael Mathers

This grossly underestimates actual emissions costs, particularly for CO_2, the primary gas causing global warming and resulting in increased severity of hurricanes, increased heat related deaths, sea-level rise, accelerating environmental degradation - such as erosion and desertification, and accelerating species extinction. A 2005 study by Harvard Medical School, Swiss Re and the United Nations Development Program summarizes a broad range of large economic costs that continued climate change and global warming, driven primarily by burning fossil fuels, will increasingly impose.[20]

Virtually all of the world's climate change scientists have concluded that human caused emissions – principally from burning fossil fuels – are causing global warming.[21] In 2004, *Science* published a review of over 900 scientific studies on global warming published in refereed scientific journals over the prior decade and concluded that there is a consensus among climate scientists that serious human induced global warming is happening.[22] In April 2005, James Hansen, Director of NASA's Goddard Institute for Space Studies, stated that "There can no longer be genuine doubt that human-made gases are the dominant cause of global warming."[23]

The USA is responsible for about one quarter of global greenhouse gas emissions. The building sector (including residential, commercial and industrial buildings) is responsible for over 40% of US CO_2 emissions – more than any other entire economy in the world except China.

The large health, environmental and property damages associated with pollution from burning fossil fuels are only very partially reflected in the price of emissions. As the health, financial and social costs of global warming in particular continue to mount, cutting greenhouse gasses through energy efficiency and greater use of renewable energy in buildings will become an increasingly valued benefit of greening buildings.[24]

Water & Wastewater Benefits of Green Schools

The 30 green schools evaluated achieved an average water use reduction of 32%. This reduction has direct savings for the building as well as substantial societal benefits from lower pollution and reduced infrastructure costs to deliver water and to transport and treat wastewater.

When there is heavy and extended rainfall, wastewater systems commonly overflow, causing water pollution and illness, river contamination and beach closings. The benefits of some green building water strategies - such as rainwater catchment and green roofs - are recognized by some municipalities. For example, in Dedham, MA, the school design team, through providing rainwater storage capacity on site, saved the town the cost of enlarging an off site stormwater detention facility. The city valued this infrastructure improvement at $400,000.[25]

A recent EPA report concludes that the expected gap between future revenues (based on historical price increases) and infrastructure needs for potable water and wastewater treatment will be approximately $148 billion over the next twenty years.[26] EPA found that nationally there is a gross under-investment in water delivery and treatment systems, indicating that current water utility rates will have to rise more steeply to secure the funds needed for required infrastructure upgrades.

An empirical study in Canada estimated that the price charged for fresh water was only one-third to one-half the long-run marginal supply cost, and the prices charged for sewage were approximately one-fifth the long run cost of sewage treatment.[27]

Prices typically reflect average rather than marginal costs. Because water and wastewater costs are generally rising, prices tend to substantially understate actual marginal cost of additional water and wastewater capacity borne by utilities and society at large. Based on discussions with school and green building experts, we can assume conservatively that water and wastewater costs for schools average 5% of the cost of energy, or about $0.06/ft^2. Assuming an average rate of cost increase of 5% per year for water and wastewater, this provides an NPV estimate of $0.84/ft^2, or roughly one dollar, over 20 years. This almost certainly underestimates the financial benefits of reduced water and sewer cost associated with green design. Nor does it reflect the large savings from reduced water runoff from green schools and the cost savings from reduced water pollution and increased groundwater recharging.

3) Few states regulate indoor air quality in schools or provide for minimum ventilation standards.
4) Almost no schools are designed with the specific objective of creating healthy and productive study and learning environments.
5) Chronic shortage of funds in schools means that schools typically suffer from inadequate maintenance, and experience degradation of basic systems such as ventilation, air quality and lighting quality, as well as poor control over pollutants (e.g., from cleaning materials).
6) Students and faculty typically spend 85% to 90% of their time indoors (mostly at home and at school), and the concentration of pollutants indoors is typically higher than outdoors, sometimes by as much as 10 or even 100 times.[29]
7) Children are growing, their organs are developing, and they breathe more air relative to their body size than adults, and as a result sustain greater health problems and risks than adults from toxics and pollutants common in schools.[30]

New LEED program for K-12 Schools
Lindsay Baker, USGBC staff

In December 2006, USGBC is launching LEED for Schools, a market-specific application of LEED that recognizes the unique nature and educational aspects of the design and construction of K-12 schools. The rating system is based on LEED for New Construction, and addresses issues such as classroom acoustics, master planning, mold prevention, and joint use of facilities. The program launch (no pilot period will take place) is supported by a full set of tools tailored to schools: a reference guide, workshop, and LEED Online with credit templates. In doing so, USGBC hopes to help school districts across the country better understand the business case for building green and to help them to implement their green building goals through a third-party certification program that is supported by educational offerings and a nationwide network of LEED Accredited Professionals, USGBC chapters and members. School districts can implement LEED without the additional cost of establishing in-house certification programs.
For more information on the LEED for Schools program, go to www.usgbc.org/leed.

Health and Learning Benefits of Green Schools

According to the US General Accounting Office, 14 million students (over a quarter of all students) attend schools considered below standard or dangerous and almost two-thirds of schools have building features such as air conditioning that are in need of extensive repair or replacement. This statistic does not include schools with less obvious but important health related problems such as inadequate ventilation. A recently published document by the American Federation of Teachers notes that the General Accounting Office found that the air is unfit to breathe in nearly 15 thousand schools.[28]

Poor health and study conditions in schools are of particular concern for a number of reasons, including:

1) There are some 60 million students, faculty and staff in schools.
2) The large majority of schools are built not to optimize health and comfort, but rather to achieve a minimum required level of design performance at lowest cost.

The costs of poor indoor environmental and air quality in schools, including higher absenteeism and increased respiratory ailments, have generally been "hidden" in sick days, lower teacher and staff productivity, lower student motivation, slower learning, lower tests scores, increased medical costs, and lowered lifelong achievement and earnings.

There is a large body of research linking health and productivity with specific building design operation attributes (e.g., indoor air quality and control over work environment, including lighting levels, air flow, humidity, and temperature).

However, many reviews of the effects of classroom healthiness on students look only at school-specific studies. This unnecessarily limits the relevant data available to understand and quantify benefits of high performance, healthy design in schools. The tasks done by "knowledge workers" (including most non-factory white collar workers) – such as reading comprehension, synthesis of information, writing, calculations, and communications

There is a large body of research linking health and productivity with specific building design attributes.

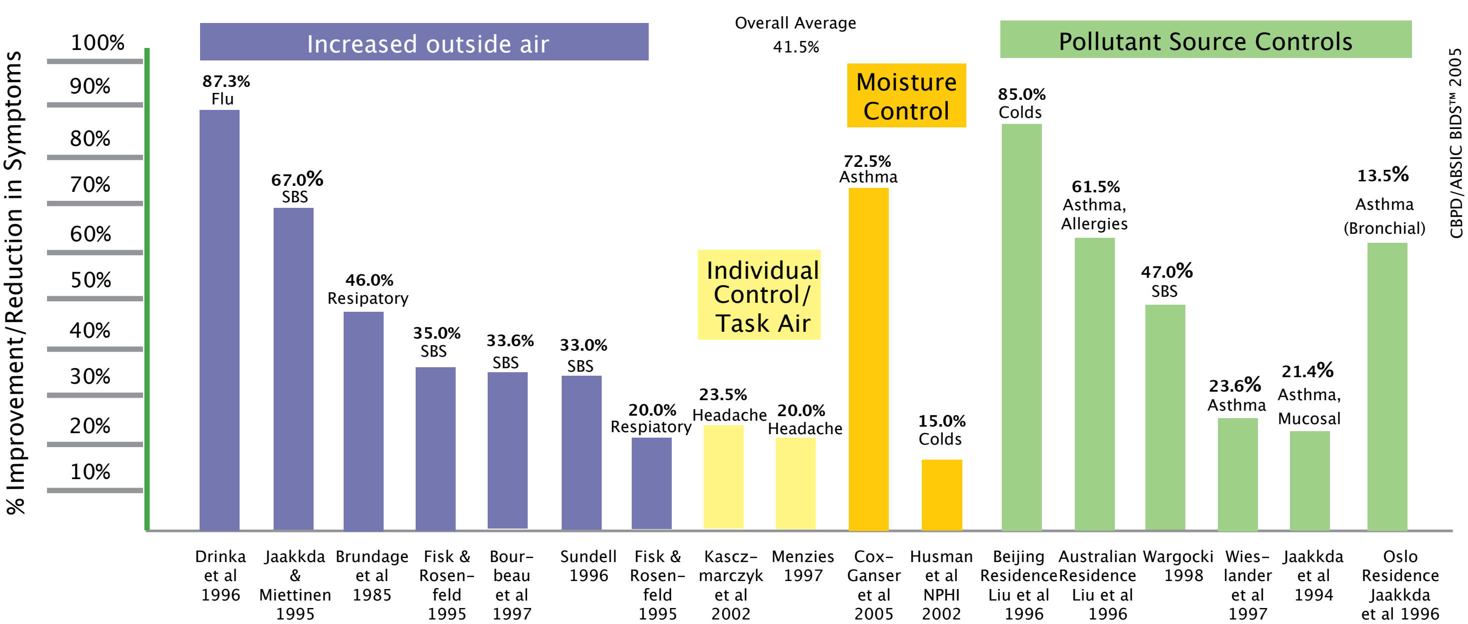
– are very similar to the work students do. Large-scale studies correlating green or high performance features with increased productivity and performance in many non-academic institutions are therefore relevant to schools.

17 separate studies all found positive health impacts from improved indoor air-quality, ranging from 13.5% up to 87% improvement.

Two studies of over 11,000 workers in 107 European buildings analyzed the health effect of worker-controlled temperature and ventilation. These studies found significantly reduced illness symptoms, reduced absenteeism and increased productivity relative to workers in a group whose workspace lacked these features.[31]

One of the leading national centers of expertise on the topic is the Center for Building Performance at Carnegie Mellon University. The Center's Building Investment Decision Support (BIDS) program has reviewed over 1,500 studies that relate technical characteristics of buildings, such as lighting, ventilation and thermal control, to tenant responses, such as productivity or health.[32]

Figure B: Health Gains from Improved Indoor Air Quality



Source: Carnegie Mellon University Center for Building Performance, 2005

Collectively, these studies demonstrate that better building design correlates with increases in tenant/worker well-being and productivity. The BIDS data set includes a number of controlled laboratory studies where speed and accuracy at specific tasks, such as typing, addition, proof reading, paragraph completion, reading comprehension, and creative thinking, were found to improve in high performance building ventilation, thermal control, and lighting control environments.[33]

Indoor Air Quality

The Carnegie Mellon building performance program identified 17 substantial studies that document the relationship between improved air quality and health. The health impacts include asthma, flu, sick building syndrome, respiratory problems, and headaches. These 17 separate studies all found positive health impacts (i.e. reduction in reported prevalence of symptoms) ranging from 13.5% up to 87% improvement, with average improvement of 41% (Figure B).

Temperature Control

Teachers believe that temperature comfort affects both teaching quality and student achievement.[34] Research indicates that the best teachers emphasized that their ability to control temperature in classrooms is very important to student performance.[35]

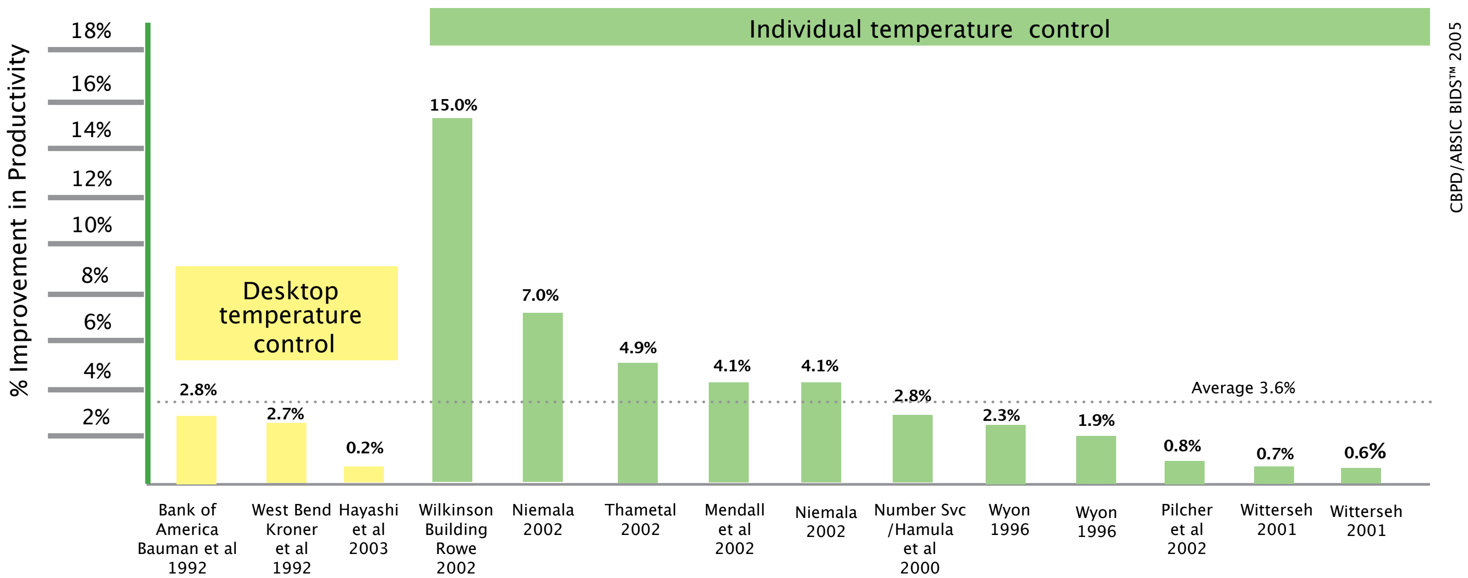
A review of 14 studies by Carnegie Mellon on the impact of improved temperature control on productivity found a positive correlation for all studies, with productivity improvements ranging from 0.2% up to 15%, and with an average (mean) of 3.6% (Figure C).

High Performance Lighting

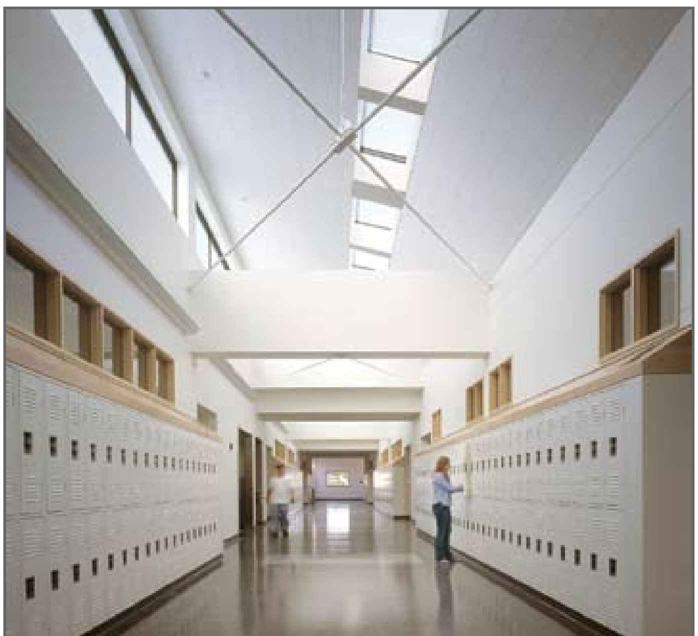
Green school design typically emphasizes providing views and managing daylight – specifically increasing daylight while eliminating glare. These two design features have both been correlated with improvements in performance on tests of office workers. In a study of 200 utility workers, workers with the best views performed 10% -25% better on tests. Workers in offices without glare outperformed workers in offices with glare by 15% or more.[36]

The consensus findings in a review of 17 studies from the mid 1930s to 1997 found that good lighting "improves test scores, reduces off-task behavior, and plays a significant role in the achievement of students."[37] Another synthesis of 53 generally more recent studies also found that more daylighting fosters higher student achievement.[38]

Figure C: Productivity Gains From Improved Temperature Controls



Source: Carnegie Mellon University Center for Building Performance, 2005



North Clackamas High School
Note entirely day-lit corridor.
Heinz Rudolf, Boora Architects
Photo: Michael Mathers

Carnegie Mellon summarized findings from 11 studies documenting the impact of high performance lighting fixtures on productivity. Their analysis found that productivity gains ranged between 0.7% and 26.1% with an average (median) of 3.2%. (Figure D).

The high performance lighting attributes include efficient lighting and use of indirect lighting fixtures, features that are normal in high performance green buildings.

Improved Learning and Test Scores

In fall 2005 Turner Construction released a survey of 665 executives at organizations involved in the building sector. Of those involved with green schools, over 70% reported that green schools reduced student absenteeism and improved student performance.[39] (Figure E).

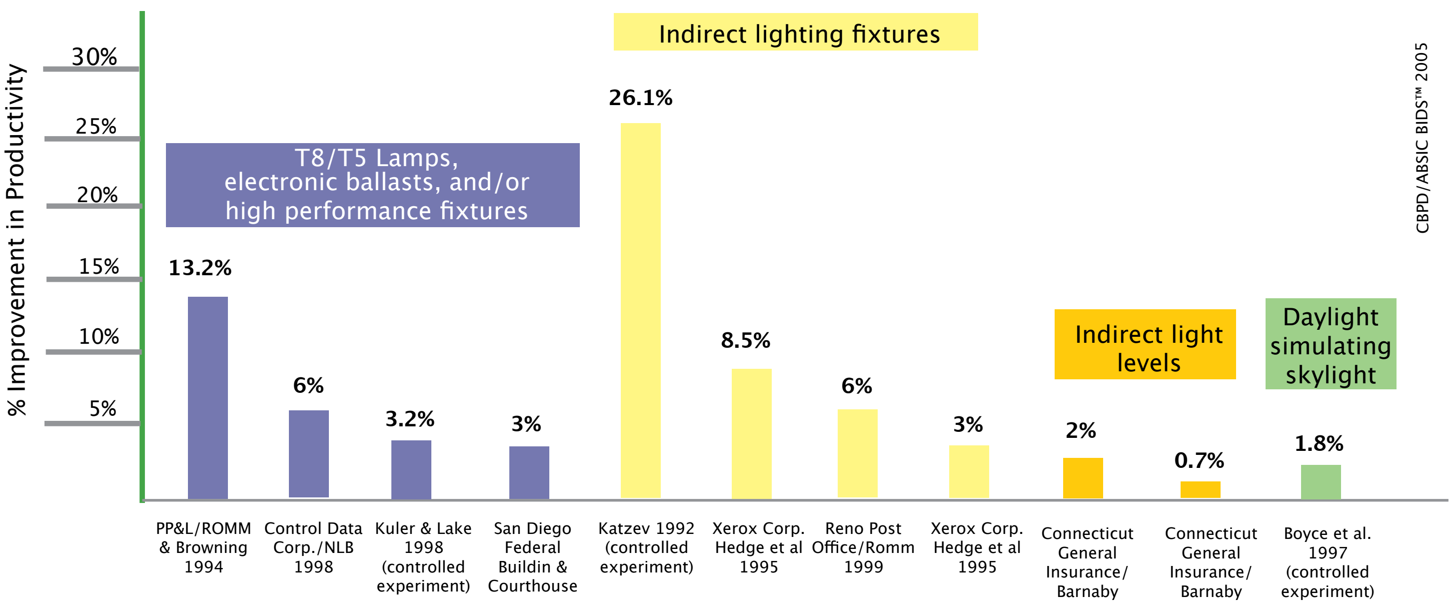
Good lighting "improves test scores, reduces off-task behavior, and plays a significant role in the achievement of students."

Greening school design is extraordinarily cost-effective compared with other available measures to enhance student performance.

A large number of school specific studies indicate a significant positive impact. For example:

- An analysis of two school districts in Illinois found that student attendance rose by 5% after incorporating cost-effective indoor air quality improvements.[40]
- A study of Chicago and Washington, DC schools found that better school facilities can add 3 to 4 percentage points to a school's standardized test scores, even after controlling for demographic factors.[41]
- A recent study of the cost and benefits of green schools for Washington State estimated a 15% reduction in absenteeism and a 5% increase in student test scores.[42]

Figure D: Productivity Gains from High Performance Lighting Systems



Source: Carnegie Mellon University Center for Building Performance, 2005

Three of the green schools analyzed for this report demonstrate similar significant improvements in performance:

- Students moving into the Ash Creek Intermediate School in Oregon (See Table B) experienced a 15% reduction in absenteeism.[43]
- Students moving from a conventional school to the new green Clearview Elementary School, a 2002 LEED Gold building in Pennsylvania (See Table B and photo on page 13), experienced substantial improvements in health and test scores. A PhD thesis on the school found a 19% increase in average Student Oral Reading Fluency Scores (DIBELS) when compared to the prior, conventional school.[44]
- The Third Creek Elementary School in Statesville, North Carolina (See Table B and front cover photo) is the country's first LEED gold K-12 school. Completed in 2002, the 800 student school replaced two older schools. Documented student test scores before and after the move provide compelling evidence that learning and test scores improve in greener, healthier buildings.

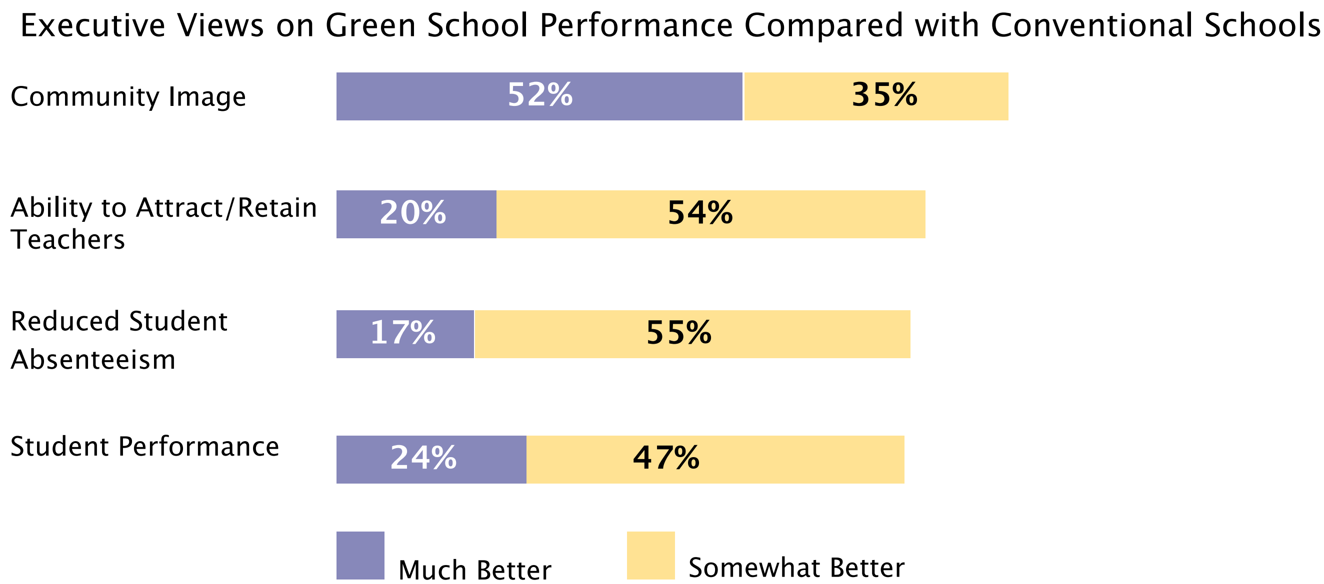
According to Terry Holliday, the Superintendent of the Iredell Statesville Schools (which includes Third Creek Elementary School),

> "Third Creek Elementary School replaced ADR and Wayside Elementary Schools, schools that were two of the district's lowest performing school in regards to test scores and teacher retention/absence. This same group of students and teachers improved from less than 60% of students on grade level in reading and math to 80% of students on grade level in reading and math since moving into the new Third Creek Elementary School. Third Creek had the most gains in academic performance of any of the 32 schools in the school system. We feel that the sustainable approach to this project has had very positive results."[45]

CHPS, LEED and other green school certifications include a range of material, design and operation measures that directly improve human health and productivity. In addition to achieving the related air and comfort quality prerequisites, the 30 green schools reviewed achieved about half the available indoor environmental quality points from features specifically designed to improve lighting, air quality and comfort.

Based on actual improvements in design in green schools and based on a very substantial data set (some of which is addressed above) on productivity and test performance of healthier, more comfortable study and learning environments, a 3-5% improvement in learning ability and test scores in green schools appears reasonable and conservative. It makes sense that a school specifically designed to be healthy, and characterized by more daylighting, less toxic materials, improved ventilation and acoustics, better light quality and improved air quality would provide a better study and learning environment.

Figure E: Benefits of Green K-12 Facilities



Source:Turner Construction 2005 Survey of Green Buildings

Clearview High School
John Boecker, Architect with L. Robert Kimball & Assoc.
Photo: Jim Schafer

Financial Impact of Improved Health and Learning in Green Schools

Future Earnings

Faster learning and higher test scores are significantly and positively associated with higher lifetime earnings.[46] A 2005 review of the financial benefits of education in an International Monetary Fund (IMF) publication concludes:

> [Recent] studies, which are based on different, nationally representative data sets that follow students after they leave the education system and enter the labor force, provide remarkably similar estimates: one standard deviation increase (moving from the average of the distribution to the 84th percentile) in mathematics performance at the end of high school translates into 12 percent higher annual earnings — an earnings gain that can be expected across the entire working life of the individual. And there are reasons to believe that these estimates provide a lower bound on the effect of higher educational achievement.[47]

A recent review of five separate studies found an average asthma reduction of 38.5% in buildings with improved air-quality.

Many elements of green design, including efficiency, renewable energy and waste diversion, increase employment.

An increase in test scores from 50% to 84% is associated with a 12% increase in annual earnings. As discussed earlier, a smaller improvement in test scores can be conservatively expected from high performance schools compared with conventional schools – in the range of 3% to 5%. Based on the IMF analysis cited above, a 3-5% improvement in learning and test scores is equivalent to a 1.4% lifetime annual earnings increase.

With average annual salary of about $38,000 per year, this improvement in learning and test scores implies an earnings increase of $532 per year for each graduate from a green school. We are assuming, conservatively, that the earnings benefits last only 20 years, even though studies indicate they last for the employment lifetime of about 40 years. Assuming that earnings rise only at the rate of inflation, the present value is about $6,800 per student, or about $49 per ft^2. (At a marginal combined federal state and local taxes rate of 40% this indicates an NPV over 20 years of additional tax revenue of $2,700 per student, or $20/ft^2. If one-third of students move to other states, state-specific employee earnings benefits decline to an estimated 20 year financial benefit of about $33/ft^2.)

Increases in earning represent the single largest financial benefit from building healthier, more productive learning environments. Greening school design is extraordinarily cost-effective compared with other available measures to enhance student performance.

Financial Benefits of Asthma Reduction

Asthma is a widespread and worsening disease among school children.[48] The American Lung Association has found that American school children miss more than 14 million school days a year because of asthma exacerbated by poor indoor air quality.[49] Nationally, about one in ten of all school children suffer from asthma.

An American Lung Association 2005 Fact Sheet on Asthma and Children notes that:

Newberg High School
Boora Architects
Photo: Michael Mathers

- Asthma is the most common chronic disorder in childhood, currently affecting an estimated 6.2 million children under 18 years; of which 4 million suffered from an asthma attack or episode in 2003.[50]
- Asthma is the third leading cause of hospitalization among children under the age of 15, and it disproportionately affects children.
- The annual direct health care cost of asthma is approximately $11.5 billion, with additional indirect costs (e.g. lost productivity) of another $4.6 billion.[51]

It costs nearly three times more to provide health care for a child with asthma than a child without asthma.[52] In 2006 dollars this amount is equal to $1,650 per child.[53] Note that most of these health costs are not borne by the schools but rather by the students and their families.

A recent review by Carnegie Mellon of five separate studies evaluating the impact of improved indoor air quality on asthma found an average reduction of 38.5% in asthma in buildings with improved air quality.[54]

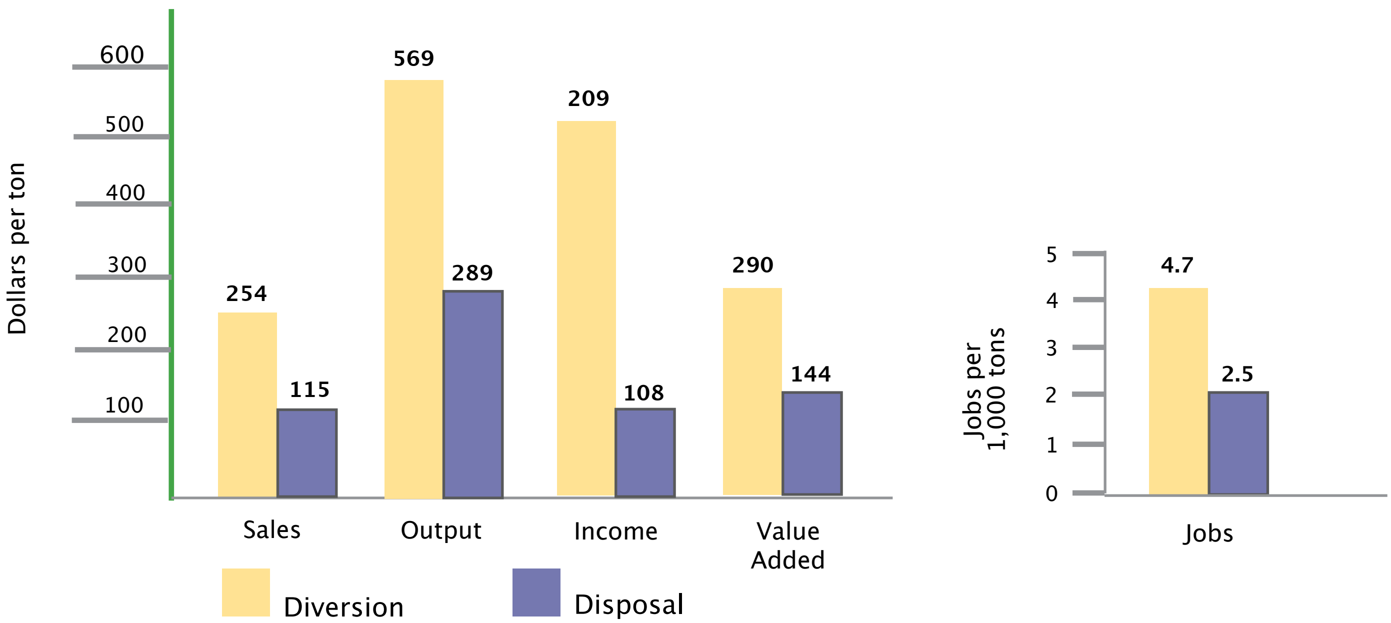
We assume the impact of a shift from an unhealthy, conventional school to a healthy school results in a reduction in asthma incidence of 25%. In an average sized new school of 900 students, a 25% reduction in asthma incidence in a healthy school translates into 20 fewer children a year with asthma, with an associated annual cost savings $33,000.[55] Over 20 years, and assuming costs of medical treatment continue to rise at the recent historical rate of 5% per year,[56] at a 7% discount rate this translates into a benefit of over $3/ft^2. A small portion of this benefit would accrue directly to the school in the form of reduced need for nurse care and staff time, while the rest would benefit families and the larger community through reduced health-care needs. This calculation underestimates the asthma reduction benefits since it does not reflect health improvements in school faculty and staff, which are only partially captured in the analysis on faculty retention impact below.

Colds and Flu Reduction

Improved ventilation and air quality reduces a range of respiratory illnesses, including common colds and influenza. A review by Carnegie Mellon of two studies evaluating the impact of improved indoor air quality on colds and flu found an average reduction of 51% in buildings with improved air quality.[57] A major review of the literature by Lawrence Berkeley National Laboratory estimates that better ventilation and indoor air quality would reduce these illnesses by 9-20% in the general population, result in 16-37 million fewer cases of the cold and influenza and provide annual savings of $6-14 billion.[58] The average impact of $10 billion, adjusted to 2006 dollars is $13 billion,[59] or about $45 per person per year.

We assume for this study that the impact on children is the same as on adults. This may be a conservative assumption (i.e., it underestimates benefits of green schools for students) because children are more susceptible to the transmission of flu and colds. Adults typically earn much more than children, so the direct cost of a child's illness is far less than for an adult. However, a child sick from school commonly either obligates a parent to stay home from work or pay for childcare to attend the sick child, and is economically disruptive. These secondary costs of children's illness are large. Better ventilation and indoor air quality in high performance schools can therefore be estimated to cut costs per pupil from reduced cold and influenza by approximately $45 per student per year. Over 20 years, and assuming costs of illness continue to rise at the recent historical rate of 5% per year, the present value of reduced incidence of influenza and colds in green schools is over $5/ft^2. As noted above for asthma, a small portion of this benefit would accrue directly to the school.

Figure F: Job Impacts of Waste Diversion vs Disposal



Source:Goldman and Ogishi, UC Berkeley, 2001

Teacher Retention

Teachers commonly express concern about school facilities and highlight the issues that green design addresses – lighting quality, temperature control, indoor air quality, etc.

Average salary and benefits for public school teachers can be conservatively estimated at $65,000.[60] A recent report on the impact of green schools in Washington State estimated a 5% reduction in teacher turnover.[61] Cost of turnover is variously estimated to be 25% up to 200% of annual salary plus benefits (this includes costs of termination, hiring, loss of learning, etc).[62] If we assume a 3% reduction in teacher turnover and the relatively conservative estimate that the cost of teacher loss is 40% of salary and benefits - about $25,000, then a 3% increase in teacher retention (at an average estimated 2,300 ft^2 of school space per teacher) translates into a financial savings of about $4/ft^2 over a 20 year period from increased teacher retention.

Employment Impacts of Green Schools

One of the reasons for the adoption of green construction requirements by cities and states is to increase employment. For example, employment benefits are one of the reasons that the New York City Council passed legislation in September 2005 requiring that significant new construction be built green.[63]

A coalition of labor movements, public entities, NGOs and businesses, called the Apollo Alliance, is advocating an ambitious national clean investment program. An Apollo Alliance analysis models a $300 billion national investment over a decade in high performance green buildings, rebuilding public infrastructure, increasing energy efficiency and investing in industries of the future (such as clean technologies), and concludes that this would create 3.3 million jobs.[64] A 2004 report by Black & Veatch on the impact of establishing a minimum energy consumption target for Pennsylvania of 10% from renewables over 20 years would, compared to business as usual, generate a net increase of $10.1 billion in economic output, increase earnings in state by $2.8 billion and

Only 2.5 jobs are created for every 1,000 tons of waste disposed, while 4.7 jobs are created for 1,000 tons of waste diverted.

result in 20,000 more jobs.[65]

75% of senior executives believe that being green improves a school's ability to attract and retain teachers.

Green buildings typically involve greater initial costs to achieve important green objectives such as improved energy efficiency, increased use of renewable energy (on site and off site), and diversion of waste from landfills for reuse or recycling. These changes create local and US jobs and offset wasteful consumption of energy (some of it imported from anti-democratic nations) and improve productivity and the US trade deficit. Each of these aspects of green design – efficiency, renewable energy and waste diversion - involves increased employment compared with conventional non-green buildings.

Third Creek Elementary School
Moseley Architects
Photo: Spark Productions

Energy Efficiency

The typical green school uses one-third less energy than conventional schools. This reduction is a result of a combination of things, including better design, more energy efficiency equipment, and installation of energy efficiency measures such as increased insulation.

A 2004 Massachusetts report found that every $10 million in additional energy efficiency investments contributes about 160 short-term jobs and 30 long-term or permanent jobs. Assuming about $200,000 in additional energy efficiency related investments in a green school relative to a conventional school, investment in energy efficiency creates three short-term jobs through additional work and half of a long-term job per school.[66]

The average income for a permanent job created can be conservatively estimated as $38,000,[67] indicating a long-term annual increase in salary in-state for each green school of $19,000 (half of one fulltime job created from increased energy efficiency). On a 20 year discounted basis, and assuming salaries grow at inflation, this is $250,000 of direct in-state salary created, equal to $2/ft^2 for a typical 125,000 ft^2 school. This calculation does not include the positive net employment impact of short-term jobs created.

Increased Use of Renewable Energy

Green buildings generally use more renewable energy, both on site and off site, than conventional buildings, primarily from purchase of green power and renewable energy credits. Use of renewable energy generally displaces less labor intensive and more polluting energy sources such as imported heating oil, gas, and coal burned in power plants to make electricity.

A shift to more renewable energy would also increase employment. Compared with a business as usual energy growth mix, expanding renewable energy use to 20% nationally by 2020 would create roughly 100,000 net new jobs nationally. The majority of these jobs would be in manufacturing and construction, and would be relatively well paid and broadly distributed (all states would experience positive employment growth) and would particularly benefit sectors of the economy suffering relatively high unemployment.[68]

It is beyond the scope of this report to estimate the positive employment benefit from increased use of renewable energy in green schools. This increase in employment is expected to be significant, so not calculating it underestimates the financial benefits of requiring that schools be green.

Waste Diversion

A third way that green schools increase employment is by diverting waste from landfills to more labor intensive activities such as separation and recycling.

A recent UC Berkeley study found that total economic impacts from diversion are nearly twice as large as the impacts from sending these materials to dumps. One ton of waste diverted to reuse/recycling generates about twice the employment impact of a ton of waste disposed in a landfill. Only 2.5 jobs are created for every 1,000 tons of waste disposed, while 4.7 jobs are created for waste diverted as recyclables (See Figure F). [69]

A comprehensive Massachusetts study on the environmental benefits of recycling calculated that the total benefits per ton were \$151-\$331.[70] As noted above, the UC Berkeley study found that diversion was about two times as labor intensive as disposal. This report does not calculate the employment benefits of increased diversion in green schools, but they appear substantial.

Conclusion on Employment Impacts

Clearly green schools create more jobs than conventional schools. Most energy used in schools comes from burning fossil fuels, some of which is imported from countries that fund terrorism. Thus, the shift to more energy efficiency, which includes in-state manufacturing, system design and installation labor for insulation, renewable energy systems, better windows, etc., would have significant positive employment, economic and security impacts. This report calculates only one of these – long-term employment impact of increased energy efficiency – and it is found to provide \$2/ft^2 of benefits.

Additional Non-Quantified Benefits

Green schools provide a range of additional benefits compared with conventional schools. Some of these are discussed below.

Reduced Teacher Sick Days

Improved air, comfort and health in green school buildings positively affect teachers. As discussed above, improved lighting, ventilation and indoor environmental quality significantly improve measured health and productivity benefits for workers in buildings. As indicated in Figure E, three quarters of senior executives interviewed for the 2005 Turner Construction survey believe that being green improves the school's ability to attract and retain teachers. A PhD thesis on the Clearview Elementary School (See table B), a 2002 LEED silver building in Pennsylvania, found that teachers experience 1.41 fewer missed working days, a 12% decrease from previous traditional school.[71] If teachers experience a 7% decrease in sick days in green schools - one day a year less because of healthy air and a better work environment - the reduced cost of substitute teachers provides a present value of about \$2/ft^2. Conservatively, this benefit is not included in this report.

Heat Island Reduction Measures

Non-reflective building surfaces absorb more sunlight, increasing temperature within buildings, as well as on exterior surfaces. In cities this effect creates urban "heat islands" and an associated need for increased air conditioning. Non reflective (typically dark) roofs can be substituted with reflective roofs or green, planted roofs – collectively known as "cool roofs" - and significantly reduce city or local temperature as light/heat is reflected back into space rather than absorbed and radiated locally. By reducing ambient urban temperatures, heat island reduction directly contributes to reduced ozone creation, in turn reducing the large human health costs associated with smog. In addition to positive energy and heat island impacts, cool roofs also experience less expansion and contraction than non-reflective roofs, which contributes to a significant extension of the roof life. Typically, highly reflective roofs last 20% longer than conventional roofs.[72] Green roofs (with plants in soil on an impermeable membrane) are expected to last 30-50 years or longer.

Research has shown that it costs less to recycle most construction and demolition waste than to dispose of it.

Lowered ambient air temperature cuts smog formation, improves comfort and health and cuts the cost of air conditioning. The financial benefits of this aspect of greening schools are substantial but are not quantified here.

Lower Operations and Maintenance (O&M) Costs

A major recent study of costs and benefits of green buildings for 40 state agencies found that the operations and maintenance (O&M) benefits of greening California public buildings provide savings worth \$8/ft^2 over a 20 year period.[73] Green schools, like other green buildings, incorporate design elements such as commissioning and more durable materials that reduce O&M costs. For example, the Canby School in Oregon, designed by Boora Architects, (see Table B) at a level equivalent to LEED Gold, features exterior surfaces of brick and metal with a baked finish that require virtually no maintenance/painting, as well as a linoleum floor with lower maintenance than conventional flooring.[74] Estimating O&M benefits from green schools is beyond the scope of this study but the benefits are probably significant.

Enhancement of Generating System Reliability and Improved Power Quality

The benefits for businesses and competitiveness from improved power quality resulting from greater energy efficiency can be large. National annual cost of power quality problems and outages have been estimated by the New York State Energy Research and Development Authority and the Electric Power Research Institute at over \$100 billion.[75] Power quality concerns are a significant issue for many businesses, and energy efficiency and renewable energy provide an important way to reduce power quality and reliability costs.

The Massachusetts Division of Energy Resources 2004 Annual Report on Energy Efficiency activities notes that:

> By reducing demand, the energy efficiency programs contribute to system reliability in terms of supply adequacy within a particular area or region… all energy efficiency measures… help maintain adequate margins of generation supply, and can help deter brownouts and blackouts…. By reducing load and demand on the power distribution network, the [efficiency] programs

decrease the costly likelihood of failures.[76]

This report does not quantify the power quality and reliability economic benefits of greening the nation's schools, but they appear substantial.

Greening public schools creates an opportunity to improve the health and educational settings for all students.

Construction & Demolition Waste Reduction Benefits of Green Schools

About 25% of the solid waste discarded nationally is construction and demolition (C&D) waste, adding up to 130 million tons of waste per year.[77] Fifty-seven percent of national C&D waste comes from non-residential building projects,[78] deriving from three sources: [79,80]

- demolition, which creates about 155 pounds of waste per square foot, and makes up 58% of national non-residential C&D waste;
- construction, which creates about 3.9 pounds of waste per square foot, and makes up 6% of national non-residential C&D waste;
- renovation, which makes up 36% of national non-residential C&D waste.

Research has shown that it actually costs less to recycle most C&D waste than to dispose of it. A rigorous 1999 study found that for all construction and demolition wastes (including mixed debris), the cost of recycling is less than the cost of disposal by at least 35%.[81]

C&D diversion rates are typically at least 50-75% in green buildings and have reached as high as 99% on some projects.[82]The green schools studied in this report have an average C&D diversion rate of 74%.The financial benefits of increased waste diversion are not estimated here but appear significant.

Insurance and Risk Related Benefits

Health related benefits from green schools have significant risk and insurance impacts. For example, according to the Chief Economist at the Insurance Information Institute, most insurers reported a tripling of mold-related claims in 2002. By early 2003, more than 9000 claims related to mold were pending the nation's courts, though most involve family homes.[83] Improved ventilation and greater commissioning in green buildings reduces the likelihood of mold and associated liability problems.

The Kats/California study characterized the potential insurance benefits of green buildings by mapping risk and insurance related benefits onto the credits of the LEED system. Each LEED prerequisite and credit was evaluated against seven types of risk: property loss, general liability, business interruption, vehicular, health & workers comp, life, and environmental liability. Of the 64 LEED points available (not including innovation credits) 49 (77%) are associated with measures that have potential risk-reduction benefits.

Insurance-related benefits of green, high performance design are summarized below (and reproduced from the Kats/California study). This report does not estimate the value of the risk and liability reduction benefits of green buildings.

Insurance Benefits of Green Buildings

•**Worker Health & Safety.** Various benefits, including lower worker's compensation costs, arise from improved indoor environmental quality, reduced likelihood of moisture damage, and other factors enhancing workplace safety.

•**Property Loss Prevention.** A range of green building technologies reduce the likelihood of physical damages and losses in facilities.

•**Liability Loss Prevention.** Business interruption risks can be reduced by facilities that derive their energy from on-site resources and/or have energy-efficiency features. These risks include those resulting from unplanned power outages.

•**Natural Disaster Preparedness and Recovery.** A subset of energy efficient and renewable energy technologies make facilities less vulnerable to natural disasters, especially heat catastrophes.

Improving Equity and Addressing Spiritual Values

Lower income and minority children disproportionately suffer from poor indoor air quality and related problems in conventional schools. Children in low income families are 30% to 50% more likely to have respiratory problems such as asthma and allergies that lead to increased absenteeism, and diminished learning and test scores. This increase in respiratory problems results in large part from exposure to polluted and unhealthy air and study conditions in schools and at home. Wealthy families can move their children into better designed and healthier private schools. Less affluent families are less likely to have that luxury. Greening public schools creates an opportunity to improve the health and educational settings for all students, regardless of income or background, a process with clear moral benefits. The financial benefits of a less inequitable educational system are difficult to calculate but could be substantial in terms of increased diversity in the work force, community development, increased productivity, etc.

Many people are spiritual and religious, and value environmental richness and environmental protection as an important spiritual issue. For example, a recent Le Moyne College/Zogby International Contemporary Catholic Trends Poll found that 87% of those polled said that protecting the environment is an important issue, with 21% placing it as "the most important issue" facing America today.[84] For many Americans, protecting the environment and God's creatures by cutting energy waste and air and water pollution is a very important part of their religious and spiritual value system.

While spiritual, religious and moral values are difficult to quantify they are important and are relevant for school design choices.

Educational Enrichment as an Aspect of Greener, Healthier Facilities

High performance schools provide hands-on educational opportunities that conventional schools do not. For example, on site renewable energy generation, water conservation features and other green technologies provide very valuable opportunities for hands-on learning. Sidwell Friends, a highly regarded Quaker affiliated school in Washington DC, is making greening a principal objective in its campus renovation and expansion. The ongoing effort to make the school's building more environmentally-friendly and healthy provides a rich source of hands-on educational material for both full time and summer students. Mike Saxenian, Assistant Head of the School and Chief Financial Officer says that "students have responded with enthusiasm to the school's decision to build green, and faculty are eager to use the new facilities as a laboratory to demonstrate solutions to environmental problems discussed in class. Trustees, faculty and administrators see the green building program as an affirmation of the school's core values."[85]

Summary of Additional Benefits

These additional benefits of greening schools – including reduced teacher sick days, lower operations and maintenance costs, improved electricity quality and reliability, reduced insurance and risk related costs, and improved educational quality - are all substantial benefits that are not quantified in this study. These additional benefits, if calculated, would greatly increase the recognized financial benefits of greening schools and further strengthen the case that building conventional relatively inefficient and unhealthy school buildings today is financially imprudent and even irresponsible.

Figure G: Executives' Views of Green Building Benefits

Source:Turner Construction 2005 Survey of Green Buildings

Note on Impact of Increased Experience with Green Buildings

There is a learning curve associated with designing and building green schools. For both public and private owners and developers of green buildings, subsequent green buildings generally cost less than the first. The trend of declining costs associated with increased experience in green building construction has been experienced in Pennsylvania,[86] as well as in Portland and Seattle. Portland's first three reported completed LEED Silver buildings incurred cost premiums of 2%, 1% and 0% respectively.[87] Seattle saw the cost premium of

The financial benefits of greening schools are about $70 per ft^2, more than 20 times as high as the cost of going green.

LEED Silver buildings drop from 3-4% to 1-2%.[88]

> **Greening schools today is extremely cost-effective, and represents a fiscally far better design choice.**

Similarly, a recent survey by the national construction firm, Turner Construction, found that the recognized benefits of green building in a range of areas, (including health benefits and productivity) increase significantly as they gain experience with green buildings (see Figure G).

For example, 78% of executives in organizations not involved with green building believe that greening a building improves health and well being of occupants, while 88% of executives in organizations with experiences of green buildings hold this view. Thus, increased experience with green buildings both reduces costs of building green and increases the recognized benefits of green design. For school districts considering greening their schools, these trends highlight the large educational and financial benefits of greening both new and existing schools.

Conclusions

Greening school design is extremely cost-effective. Green schools cost on average almost 2% more, or \$3 more per ft^2, than conventional schools. The financial benefits of greening schools are about \$70 per ft^2, more than 20 times as high as the cost of going green. Only a portion of these savings accrue directly to an individual school. Lower energy and water costs, improved teacher retention, and lowered health costs save green schools directly about \$12/ft^2, about four times the additional cost of going green, and enough to hire an additional full-time teacher.

Financial Benefits of Green Schools (\$/ft^2)	
Energy	\$9
Emissions	\$1
Water and Wastewater	\$1
Increased Earnings	\$49
Asthma Reduction	\$3
Cold and Flu Reduction	\$5
Teacher Retention	\$4
Employment Impact	\$2
TOTAL	\$74
COST OF GREENING	(\$3)
NET FINANCIAL BENEFITS	\$71

Analysis of the costs and benefits of 30 green schools and use of conservative and prudent financial assumptions provides a clear and compelling case that greening schools today is extremely cost-effective, and represents a fiscally far better design choice. Building green schools is more fiscally prudent and lower risk than continuing to build unhealthy, inefficient schools.

Endnotes

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Greening America's Schools
Costs and Benefits

"The choices we make in new construction have huge implications for the health of students, faculty and staff. Unfortunately, too many of America's 55 million elementary through high school students attend schools that are unhealthy and unsound, and inhibit rather than foster learning. This important study persuasively demonstrates that it costs little more to build high performance, healthy schools and that there are enormous financial, educational and social benefits to students, schools and society at large."

- Edward J. McElroy, President, American Federation of Teachers, AFL-CIO